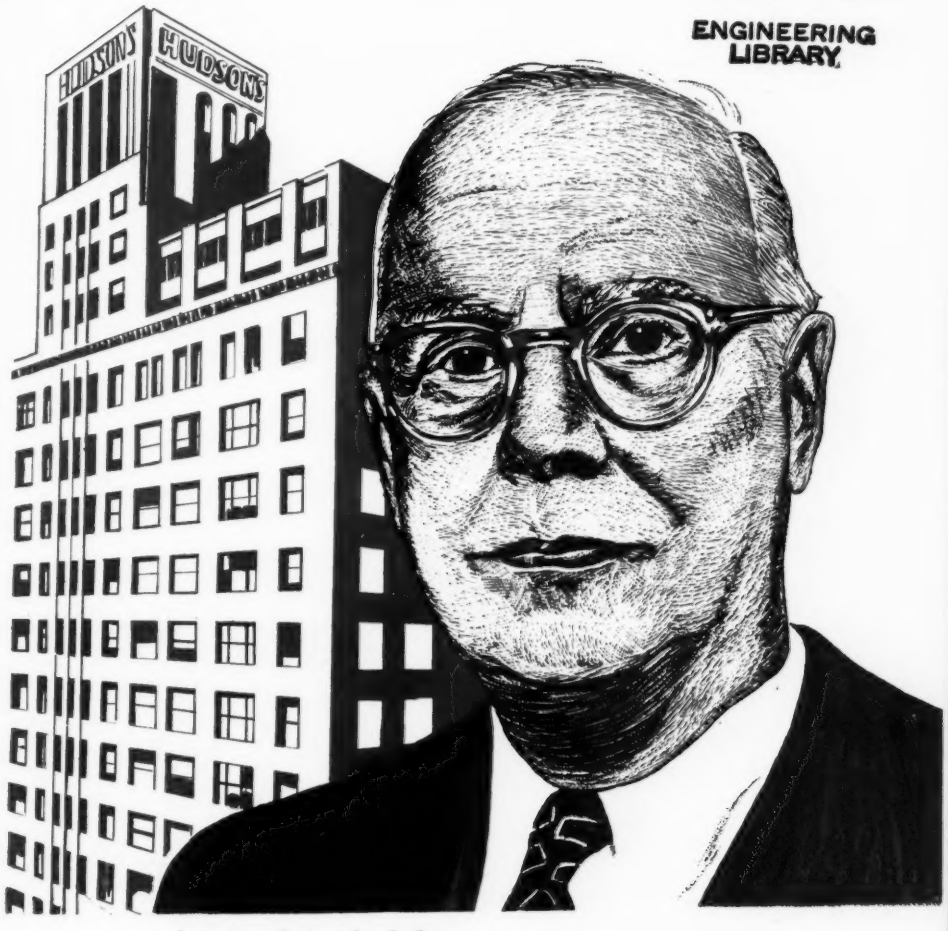
consulting engineer

Idea Mine for Consultants
Timber Construction
Control of Air Pollution
Break-Even Charts
Consultant vs Plant Engineer
Linear Programming
Microfilm Your Drawings
Coming Role of Titanium



. . . . *changing Detroit's skyline*

A Full Life

WALLACE S. MacKENZIE has his own noon-hour prescription for relaxing from the cares of his busy office. Billiards. And while he won't post any guarantees or bonds that this is a sure-cure for ulcers or falling hair, his own enthusiastic vigor, ready smile, and keen sense of humor are the best

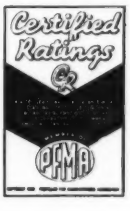
—Continued on page 6

TRUST A TESTING LAB TO BUY ON PERFORMANCE

A laboratory that tests ventilating equipment is in a good position to select efficient ventilators for its *own* buildings. Texas Agricultural and Mechanical College is the authorized neutral laboratory certifying fan capacities for the Power Fan Manufacturers Association. Familiar with all types of fan equipment, this college chose DeBothezat Power-Flow Roof Ventilators for its new Veterinary Hospital.

GET ALL THE AIR YOU PAY FOR

Capacity ratings of DeBothezat Power-Flow Roof Ventilators are the output of the completely assembled unit, *including the head.* These ratings are obtained from wind tunnel tests conducted in accordance with NAFM Standard Test Code Bulletin number 110, Plate VIA. They conform to U. S. Department of Commerce Standard 178-51, which embodies the test codes of ASHVE, NAFM and PFMA.



Next time you buy or specify roof ventilators, consider their cost in terms of CFM. And for your own protection, ask the manufacturer how he arrives at ventilator capacity ratings.

DeBothezat Power-Flow Roof Ventilators atop the Veterinary Hospital at Texas A&M College. Hospital built under the direction of Arch C. Baker, Texas A&M College System Architect, and J. W. Hall, Consulting Engineer.

SEND FOR FREE CATALOG

DeBothezat Fans

DeBothezat Fans Division
American Machine and Metals, Inc.
Dept. CE-554, East Moline, Illinois

Send Catalog DR-3-53 containing certified ratings and complete data on Power-Flow Roof Ventilators.

FIRM NAME _____

ADDRESS _____

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NAME AND TITLE _____

VOLUME 3

NUMBER 5

Published by Industry and Power Publications

consulting engineer

MAY 1954

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A Full Life

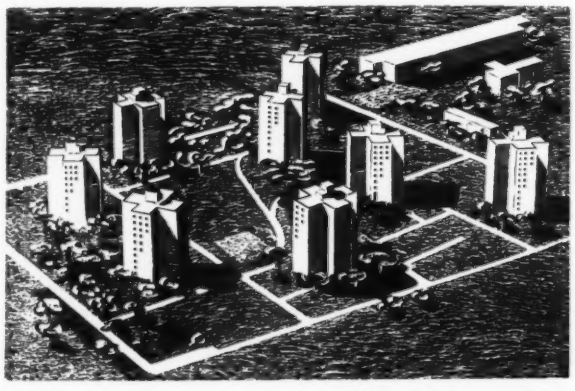
—Starts on front cover

advertisement for MacKenzie and his ideas.

Mr. MacKenzie enjoys reminiscing—and as President of Smith, Hinchman & Grylls, he can occasionally tilt back his office chair, clasp his hands behind his head, and let his thoughts wander.

Detroit Skyline

From his window he can see the Detroit skyline and the buildings that represent milestones in his professional engineering life. Structures like the Buhl, Guardian, and Penobscot office buildings; or the J. L. Hudson, Kern, and Crowley-Milner department stores; the Detroit Federal Reserve Bank, Main Bell Telephone, Gas Company, and others; all of which have helped to establish Detroit as an important metropolitan center.



MacKenzie supervised the structural calculations, design features, and mechanical problems of his projects during this era of downtown development. He left his personal imprint on the character of the Detroit skyline in helping to solve the many complex engineering details and methods.

Today, in his organization of almost 500 men, there are plenty of good architects and engineers who are handling similar design problems, and, in turn, leaving their personal imprints on projects ranging from chemical plants to administrative centers. But now, these men rely upon MacKenzie to establish policies that will keep the company in step—and perhaps even ahead—of the times.

Pleasant Interlude

Scotland and whiskey! An especially fine combination if your name is MacKenzie and your company has just landed a contract to build a distillery in the Highlands. (It was no coincidence, however, since some of Mr. MacKenzie's outstanding work has been in the chemical industry and includes numerous plants for both Hiram Walker and Joseph E. Seagram.) As it happened, Mr. MacKenzie decided that this project needed his personal touch—so bag and baggage and Mrs. MacKenzie in tow, they went off to Dumbarton for a few months. He still has warm recollections of the friends, hospitality, and rounds of entertainment they both enjoyed during their stay in Scotland.

On the walls of his office hang pictures of probably the three most important persons in his life. His wife, prominent in Detroit circles for her charitable activities; a housewife and companion to her husband for close to 40 years.

An only son—pictured in the Navy officer's uniform he wore during the last war—and now a surgeon gaining recognition in his chosen field. Not so many years ago, MacKenzie made the transition to grandfather—a fact of which he is proud.

A painting of Mr. Hinchman, one of the original founders, watches over his protege. Back in 1915, Hinchman persuaded MacKenzie, as a young engineer, to leave his home in Ontario and come to Detroit. At the time, it was a big decision—but looking back, it's hardly been one to regret. Chance may have brought him with the firm, but loyalty, ability, and vision have carried him to the top.

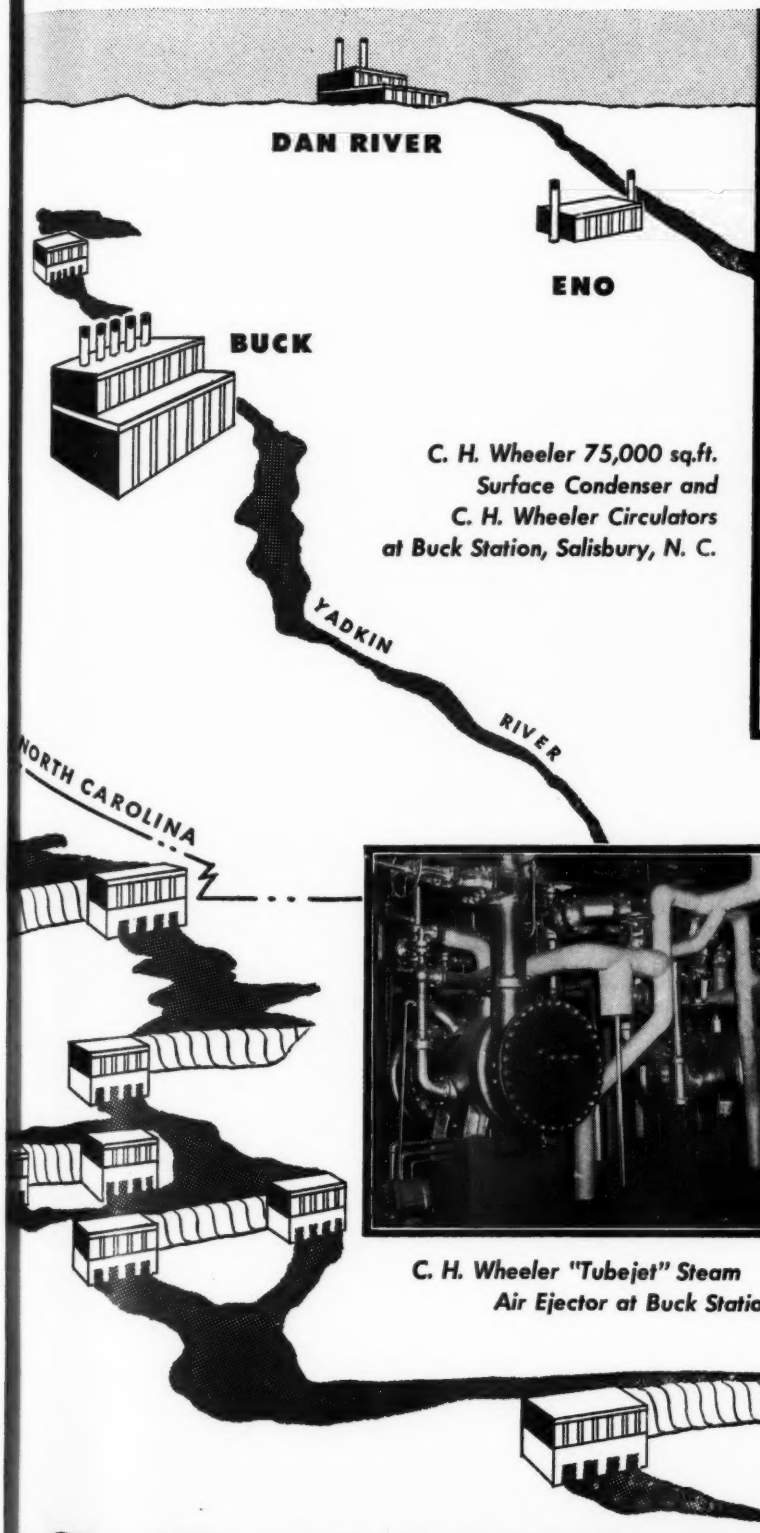
On most subjects MacKenzie is very broad-minded. But on some, he has little patience. He cannot understand, for instance, why the labor unions spend so much time and effort arguing over seeming trivialities. If everyone concerned would roll up his sleeves and tackle the job at hand, instead of worrying about the location of candy machines, the quality of the towels in the lavatories, or just plain argument for argument's sake, both labor and management would benefit.

Then there's the subject of retirement. At the age of 65, MacKenzie is a fine looking man. His health is good, his mental faculties keen and alert. He feels that there are many top-level executives in similar circumstances who have invested most of their professional life in building an organization. To retire at the peak of their capacities and experienced judgment is a mistake. It's a mistake for the company and it's nothing less than a cruelty imposed upon the man.

As long as he can pull his weight, MacKenzie will continue with the firm. Not overlooking the eventual day—"we are not getting any younger"—MacKenzie is preparing his staff members to assume the necessary additional responsibilities.

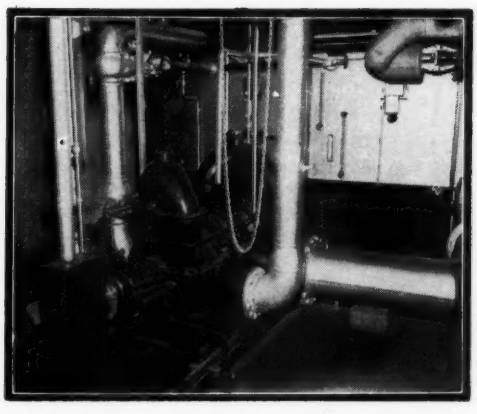
For the near future, MacKenzie sees the continuing trend towards suburban growth, both for industrial plants and community centers. And perhaps a little more distant, the practical applications of atomic energy will, he feels, reflect major changes in our way of living and the pattern of our cities and industries. In any event, there will be plenty of challenges for the profession in designing and building this future.

C. H. WHEELER
STEAM CONDENSERS—AIR EJECTORS
CIRCULATING AND CONDENSATE PUMPS



C. H. Wheeler 75,000 sq.ft. Surface Condenser and C. H. Wheeler Circulators at Buck Station, Salisbury, N. C.

C. H. Wheeler "Tubejet" Steam Air Ejector at Buck Station



C. H. Wheeler 5-stage Condensate Pumps Operating on a Split Cycle System with a balancing standpipe between stages

C. H. WHEELER *of Philadelphia*

C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

READERS' COMMENT

Demineralization vs Evaporation

Sir:

I have just read an article by Baron and Gabel in the February number of CONSULTING ENGINEER. These two gentlemen are to be congratulated for having produced an extremely remarkable design. They have shown in Figure 1 an evaporator layout that they say has "high thermal efficiency." I believe that they are grossly understating the case, because, so far as I can make out from the figure, the evaporator takes no steam at all, which is really a most epoch-making development.

I have worked most of my life with evaporators and evaporator design but, unfortunately, being only a lowbrow chemical engineer and having been concerned only with evaporators in the process industries, I am quite ignorant about the intricacies of power plant make-up evaporator flow sheets. If, however, it is possible to run evaporators without any steam supply at all, this is something that most of us would like to know about.

W. L. Badger
Consulting Chemical Engineer
Ann Arbor, Michigan

● UNFORTUNATELY, STEAM IS STILL REQUIRED. STEAM LINES ARE SHOWN BY DASHED LINE, THUS — — — —

Sir:

I have just read the excellent article entitled "Demineralization vs Evaporation For Treating Power Plant Makeup Water" by Dr. S. Baron and I. Gabel, which appeared in the February, 1954 issue of CONSULTING ENGINEER. I should like to point out one correction, however. The first demineralizing plant for supplying low silica demineralized makeup water to a boiler was one which we installed at the Muscatine Light & Power Company, Muscatine, Iowa. This plant was placed into operation in May, 1948.

M. E. Gilwood
Director of Research
The Permutit Company
New York, New York

● DR. BARON WRITES: "The information as to the first complete demineralization to treat boiler make-up water in a central station was obtained from an article by I. L. Wade, Manager of Electric Production, Public Service Co. of Northern Illinois, entitled 'Demineralization Produces Plant Savings', which appeared in the October, 1950 issue of *Power*."

● WE APPRECIATE THE CORRECTION BY M. E. GILWOOD. IT WOULD SEEM THAT THE MUSCATINE INSTALLATION WAS FIRST.

N.Y.A.C.E. Booklet

Sir:

The very interesting March issue of CONSULTING ENGINEER has an article called "NYACE activities Build Prestige." I would like to write to the Association and would appreciate receiving from you their address. I am also interested in the manual they are publishing. Can you supply copies of the manual, or should I write directly to NYACE.

Salvatore S. Guzzardi
Consulting Engineer
Philadelphia 2, Pennsylvania

Sir:

. . . . . I would like to secure a copy of this publication as soon as it is available and if you will advise me of the cost, carrying charges, etc., I will be pleased to send the amount to you.

Kenneth A. Heron
Consulting Engineer
Denver, Colorado

● FOR COPIES OF MANUAL WRITE: JOHN K. M. PRYKE, SECRETARY, NEW YORK ASSOCIATION OF CONSULTING ENGINEERS, 220 EAST 42ND ST., NEW YORK 17, NEW YORK.

Engineer's Status

Sir:

Your writer of "Scraps & Shavings" is doing a good job. Is the American engineer a professional man or a wage earner? . . . while engineering

INSULATED METAL WALLS

for INDUSTRIAL and COMMERCIAL BUILDINGS

ALUMINUM, STAINLESS or GALVANIZED STEEL

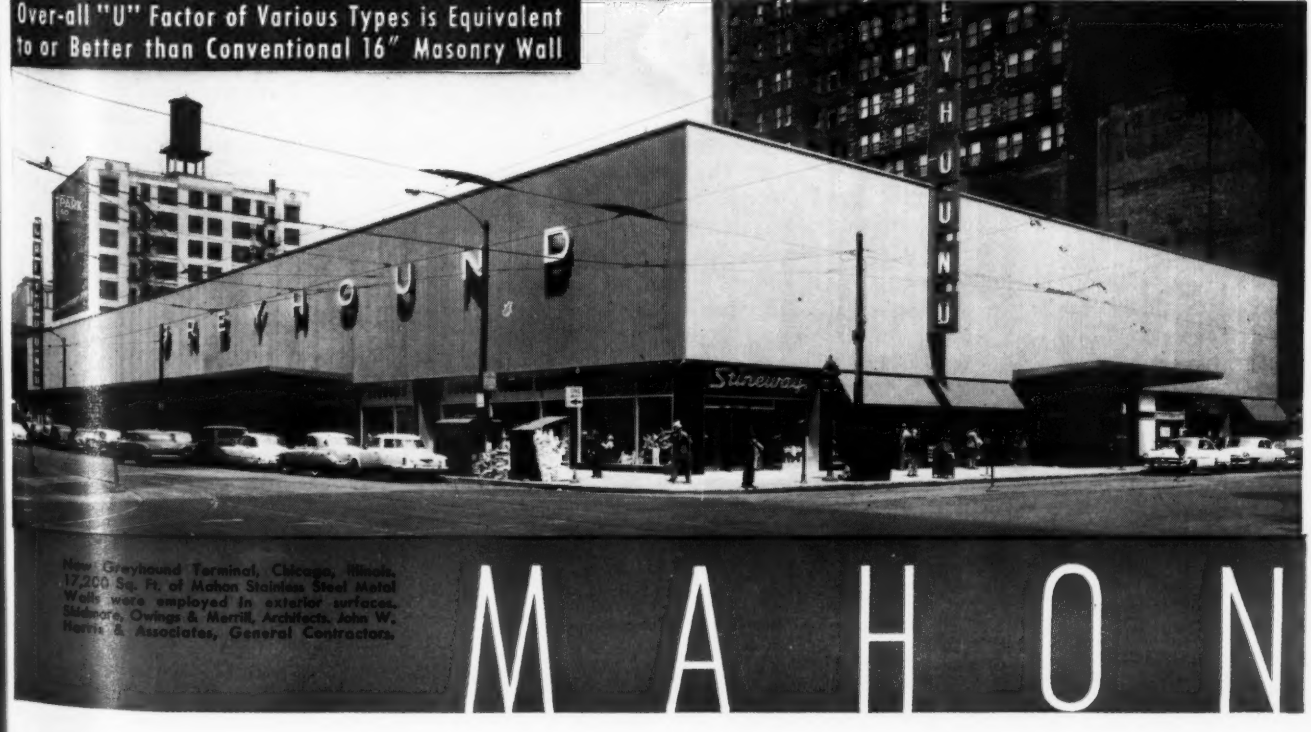
FLUSH, RIBBED, or FLUTED
Over-all "U" Factor of Various Types is Equivalent to or Better than Conventional 16" Masonry Wall

Here is another excellent example where Stainless Steel Metal Walls have been employed to good advantage in dressing up a building which, because of its functional characteristics, would otherwise have been rather prosaic in appearance. The architects have achieved in this structure a result in modern design which has attracted much interest and many enthusiastic comments. The advantages of Metal Walls, however, are not confined to appearance and design effects obtainable . . . important building economies are realized through lower material cost, lower labor cost, and the cumulative savings resulting from reduced construction time . . . buildings can be quickly enclosed with Insulated Metal Walls—even under extreme low temperature conditions which would preclude masonry construction. Other important factors to be considered are the light weight of these modern curtain walls and the maintenance-free permanence of Stainless Steel or Aluminum exterior surfaces. Mahon Insulated Metal Walls are available in three exterior patterns . . . the Mahon "Field Constructed" Fluted or Ribbed Wall can be erected up to sixty feet in height without a horizontal joint—a feature of Mahon Walls which is particularly desirable in auditoriums, powerhouses and other types of buildings where high expanses of unbroken wall surface are common. See Sweet's Files for complete information or write for Catalog No. B-54-B.

THE R. C. MAHON COMPANY

Detroit 34, Mich. • Chicago 4, Ill. • Representatives in All Principal Cities

Manufacturers of Insulated Metal Walls and Wall Panels; Steel Deck for Roofs, Partitions and Permanent Concrete Floor Forms; Rolling Steel Doors, Grilles and Underwriters' Labeled Rolling Steel Doors and Fire Shutters.



New Greyhound Terminal, Chicago, Illinois. 17,200 Sq. Ft. of Mahon Stainless Steel Metal Walls were employed in exterior surfaces. Skidmore, Owings & Merrill, Architects. John W. Harris & Associates, General Contractors.

MAHON

is a profession, engineers are not always professional people.

The reason the daily papers are full of advertisements for engineers is because the word is either misused or is all too inclusive.

If the medical profession would include nurses, orderlies, pharmacists, or what have you under the word "doctor", the dailies would have columns for "doctors" just as for "engineers."

Have you ever heard of an orderly, having served in a hospital for 25 years, had been elevated to chief surgeon? No! Have you heard the statement that Mr. A. started as an office boy and raised himself to chief engineer and manager of engineering? Yes!

Jacob Yavitch
Reg. Prof. Engineer
Glen Olden, Pennsylvania

Consulting Engineers' Address

Sir:

Could you please tell me the address of the national office of the American Society of Consulting Engineers?

D. P. Kennedy
Consulting Engineer
Erie, Pennsylvania

● 33 WEST 39TH ST., NEW YORK 18, N. Y.—ED.

Free Piston Engines

Sir:

I understand that an article or review on the free piston engine has been published in CONSULTING ENGINEER.

Will you please be good enough to send us a copy of this article.

Mary E. Agee, Librarian
American Gas Association
New York 17, New York

● MAJOR ARTICLE ON THIS SUBJECT APPEARED IN AUGUST 1953—ED.

Letters to the Editor

The Editors of Consulting Engineer welcome letters from readers. If you find articles on subjects with which you have had some experience, we would like to have your comment to pass along to other readers. We also welcome comment on any problems of professional practice or engineering ethics. Your name and firm name will be withheld on request.

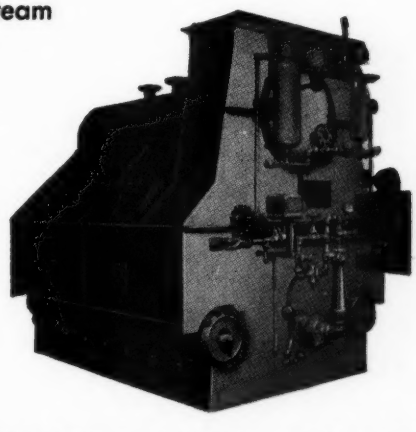
OWERHOUSES SINCE 1854

WICKES

STEAM GENERATORS

You'll find the real proof of WICKES' years of experience in the powerhouses across the nation . . . in the foundries and factories, the public utilities, the refineries and natural gasoline plants, in the schools, hospitals and other public buildings that depend on steam for low-cost heat and power. Wickes supplies steam generating equipment to thousands of industries and institutions.

WICKES will design and build water tube steam generators for any practical size and pressure. Wickes also offers a wide choice of auxiliary equipment so that it's possible for you to get not only the best steam generator but also the best correlated equipment. Contact your nearest Wickes sales representative or write us today.



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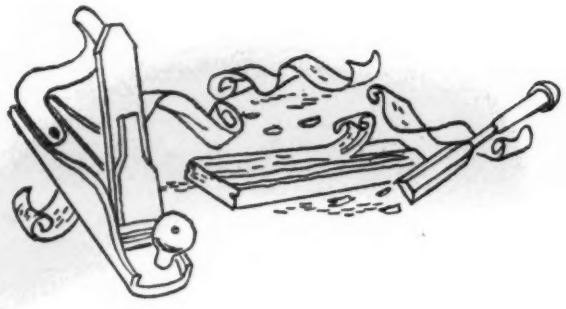


SCRAP & SHAVINGS

ELGIN ROBERTSON, a good engineer and a good Texan who is currently President of the American Institute of Electrical Engineers, wrote a letter to his members last month which was published in the Society magazine, *Electrical Engineering.* This is an informative and important message on the subject of unity for the engineering profession. It takes the form of a report from a special committee of the Board of Directors which reviews the history of the efforts toward unity of the engineering societies and concluded with some very forceful and interesting words directed at the Engineers Joint Council.

First, the committee points out that as a result of the report of EJC's Exploratory Group, eight engineering societies were invited to join EJC to work for some sort of eventual society confederation. Of these, three accepted the invitation. These were the American Society for Engineering Education, the American Water Works Association, and the Society of Naval Architects and Marine Engineers. Two organizations, the Institute of Radio Engineers and the National Society of Professional Engineers, rejected the invitation. Three, the American Association of Engineers, the American Society of Heating and Ventilating Engineers, and the Institute of Aeronautical Sciences, did not respond at all.

The real question was whether or not the National Society of Professional Engineers would join. They were in about the same position as was the State of New York on the question of ratification of the U. S. Constitution—all the lesser states were needed, but without New York, there would not have been much hope for permanent union. In this instance, "New York" did not see fit to go along with the idea. NSPE felt that the whole idea of a top level federation which did not include any individual local organization membership or representation was wrong and would fail.

The American Institute of Electrical Engineers now comes to the support of this position by stating:

"1. Thirty years of experience both in the United States and Canada show that the top level federation or council type of organization has been inadequate to meet the requirements of the engineering profession especially in nontechnical activities.

"2. The Council-type organization is less secure than an organization founded upon individual membership because of the ability of an entire society of several thousands of members to withdraw at one time.

"3. The financial support of a Council-type organization is less secure than for one founded upon individual membership for the same reasons cited in item 2."

This means that one of the Founder Societies has finally come to an understanding of the truth. Equally important, one of the Founder Societies has been stirred from what appeared to be a state of profound lethargy to take some much needed action. This report specifically asks "that EJC immediately takes steps toward the development of a unity organization based upon individual membership."

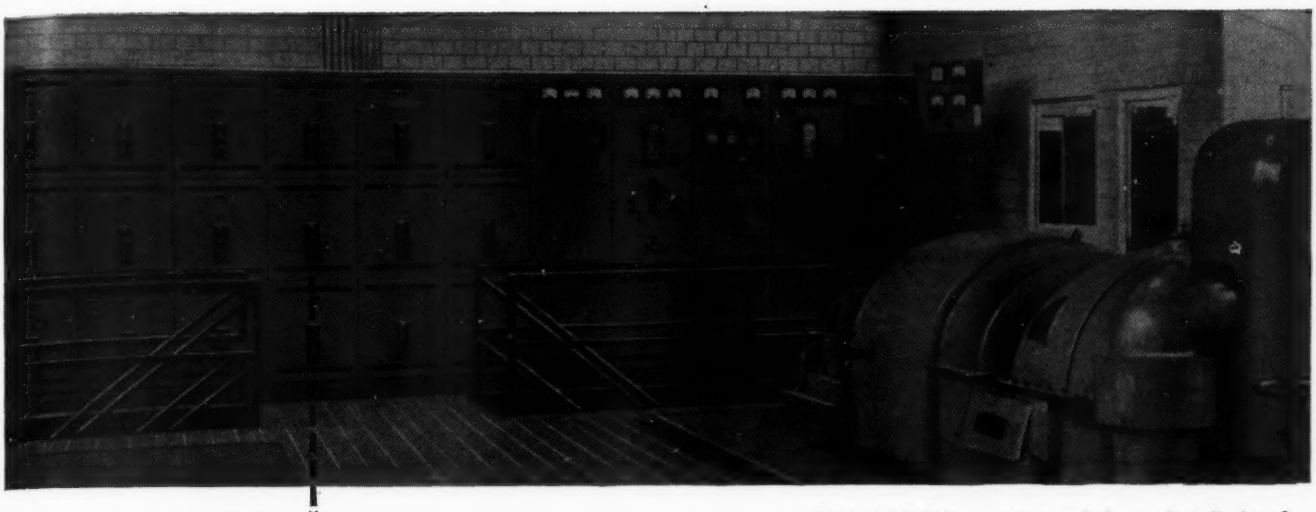
This is good. It is important.

Not that we think Engineers Joint Council is going to take any action. We don't. It would be out of character entirely. But we do think that there is an indication that the members of AIEE have about reached the end of their waiting. And if the Board of Directors of AIEE can find one or more of their fellow Founder Societies brave enough to go along with them, could they not arrange for a meeting with the National Society of Professional Engineers to work out a plan for full overlapping of membership which would result in NSPE becoming every engineer's professional society while he maintained his membership in the technical society of his chosen field of engineering?

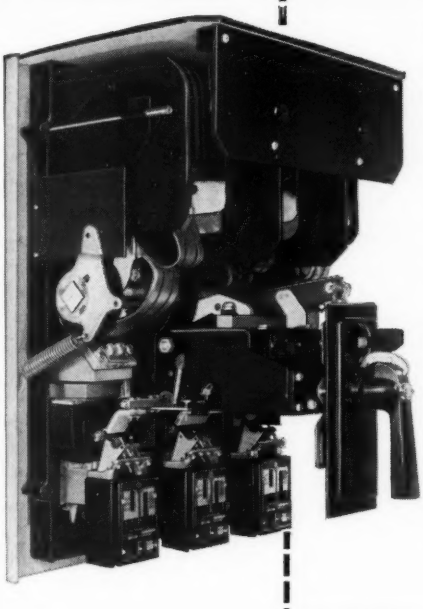
Any such arrangement would demand a lot of "give and take" on both sides, and the bugbear of sovereignty would have to be overcome.

The Board of Directors of AIEE is rightfully impatient. We hope their acknowledged impatience inspires the other Founder Societies and the other members of EJC to recognize the futility of further negotiation for unity on the "Council" level.

Elgin Robertson is a man of action and an independent and clear thinker. He and his Board have indicated that they recognize the true situation. We would suggest to Mr. Robertson that in the eyes of thousands of engineers throughout the country, he is carrying the ball. We as spectator-members can merely cheer him on. We hope he gains ground before the whistle signals the end of his term of office as President of AIEE. ▲▲



Typical I-T-E low-voltage switchgear installation for modern, efficient control of power generators.

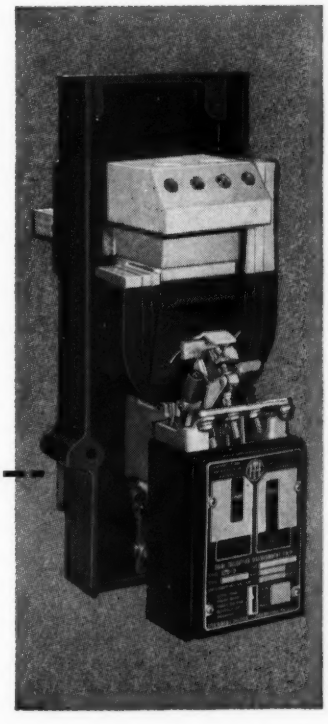


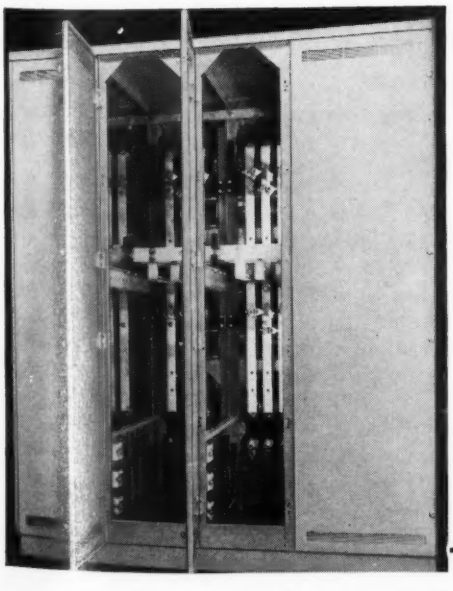
PROVED CIRCUIT PROTECTION

I-T-E air circuit breakers are sturdy, metal-base units with complete insulation of all current-carrying parts. The high-pressure silver contacts are strong, durable, and fast operating. Reliable contact action and efficient magnetic arc chutes assure positive interruption in a small space. Maximum flexibility, simplified testing and inspection are made possible by the horizontal drawout feature.

COORDINATED "SELECTIVE TRIPPING"

This *direct-acting* OD-2 trip device isolates system faults by tripping only the breaker nearest the fault. The OD-2 is a compact, shock-resistant, sealed unit. "Dual selective," it offers precise long-time delay in seconds and minutes, and short-time delay in cycles.





ENGINEERED FOR SERVICE

The entire switchboard is carefully engineered to provide accessibility of components . . . safety for personnel . . . long life . . . ease of operation. Typical of its convenient design is the rear section with its full-height hinged doors. Rugged, structure-high frames eliminate the need for cross-bracing. Thus cable connections can be made simply and easily. Main horizontal bus is located deep inside the compartment—a construction feature which allows ample space for instrument transformers, bus duct, and cable connections. Generous-sized bus is braced to withstand maximum short-circuit conditions.

LOW-VOLTAGE SWITCHGEAR

ECONOMIC NEWS NOTES

E. F. Mac Donald
INDUSTRIAL ECONOMIST

MEET THE CHALLENGE—Government contracts are all right in their place, but E. D. Reese, president, American Bankers Association, has called upon American businessmen to "take up the slack" in business and keep the Government from taking its own steps to prevent a depression. He told the Georgia Bankers Assoc. that the challenge to private business is to "take up the slack of the reconversion from a peak defense effort" and to thus back up with actions the demand for a "fuller expression of free enterprise."

DOUBLE TROUBLE—There may be, as is so frequently stated, a shortage of engineering students, but for a much more serious situation look at the grade-school problem. In reviewing this problem, President Griswold of Yale estimated that the current shortage of 325,000 classrooms would be increased by another 425,000 by 1960. He pointed out that in the face of a rapidly increasing enrollment of students, the supply of teachers is actually declining. The projected need for elementary school teachers last year was 160,000; our colleges produced 36,000. For a secondary-school enrollment on the way to doubling itself we turned out 86,000 teachers in 1950, 73,000 in 1951, 61,000 in 1952, and 55,000 in 1953.

OPTIMISTIC CLAIM—If a more realistic and more liberal method of taking depreciation on machinery is allowed by the new tax bill, H. L. Tigges, president, National Machine Tool Builders Assoc., holds that industry will start a modernization program that will dwarf anything we've seen in many years.

UP IN SMOKE—Fire losses during March totaled $84.8 million, 1.6% more than in March 1953 and 7.5% greater than the preceding month. For the first three months of this year, fire losses amounted to $250 million, 7.5% over the first quarter a year ago.

CONSUMER SHIFT—The most important factor in business activity, consumer purchasing, has been a "sustaining market factor during the business downturn of the past nine months," reports the Commerce Dept. Despite an increase in unemployment, consumers are spending nearly as much as they did a year ago. An important change in distribution of spending has occurred, with less being spent on autos and other durable goods and more for personal services.

DEPRESSIONS PASSE?—The Federal Government's recognition of its responsibility for preventing economic depressions is now backed up by the economic "know-how" to carry out this charge. So said T. O. Yntema, vice president of Ford Motor, to a recent meeting of the National Petroleum Assoc., holding that "A great depression like that of the early 1930's is impossible now, because of stabilizing factors in the present economy."

SOME SAY MORE—The results of the latest McGraw-Hill survey of plans for plant and equipment outlays this year by large manufacturers indicate a slight rise over last year. It's not much of a gain—$12.4 billion as against $12.3 billion total last year—but it's a surprising one since the companies expect their sales to decline about 2%. Spending for modernization will increase while outlays for expansion will decline.

SOME SAY LESS—Completion of defense-supporting projects is regarded by some authorities as likely to cause reduction in spending for plant and equipment this year. By the end of 1953, 69% of the $29 billion of new plant and equipment investment covered by certificates of necessity had been put in place. During the year there was a slowing down in the rate at which new certificates were issued.

NEW ERA—Automation, the new technology of automatic controls, has already had its "shake-down," and its reliability is steadily improving, says Mr. J. Diebold, consultant and automation specialist. He claims that in the future it will double our productivity, permit the manufacture of products completely unknown at present, shorten working time, and effect great changes in our manner of living. He sees as the important problem today the question of how and when to use automation.

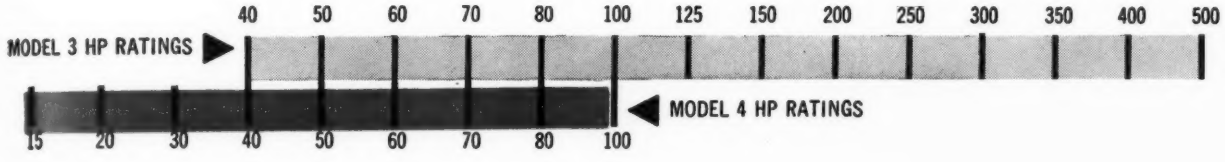
QUOTE OF THE MONTH—"Forecasting will work occasionally, but I never saw one work all, or most, of the time. I know of no way to deduce the future with certainty . . . . Subtle understanding of economic change comes from a knowledge of history and large affairs, not from statistics or their processing alone—to which our disturbed age has turned so eagerly in its quest for certainty." Arthur F. Burns, "The Frontiers of Economic Knowledge" (Princeton Univ. Press)

BY THE WAY—There are now eleven private companies authorized to do research in the practical application of atomic energy . . . . Microwave radio is expanding in a big and fast way, taking over one after another new industrial jobs . . . . The order backlog for freight cars at the beginning of April was only one-third the backlog a year earlier and one-seventh what it was April 1, 1951 . . . . A significant finding in the recent survey by the National Retail Dry Goods Assoc. indicates that an increase in sales and profits is expected by department and specialty stores in the second half of this year . . . . Shipbuilding in American yards dropped to a 3-year low in March which was the 15th consecutive month of no new contracts . . . . A single air group, afloat or land-based, can deliver to any target in range a destructive drop exceeding in power all the bombs that fell on Great Britain during all of World War II.

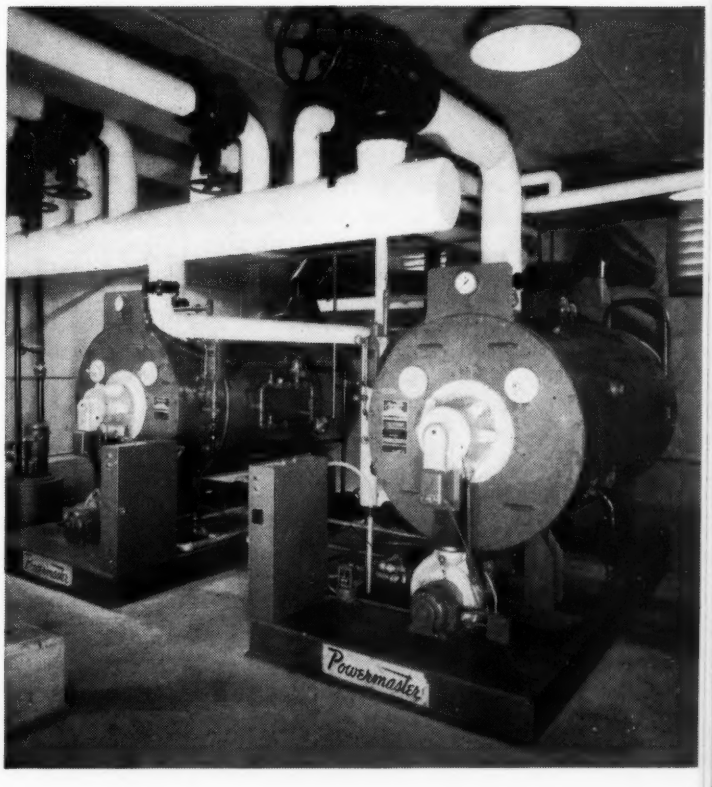
a choice of 2

Powermaster Packaged Automatic Boilers to meet your specific operating requirements... to your best advantage.

for 15 to 250 psi. steam or hot water



Model 4 *Powermaster*—Service-proved in wide variety of successful applications. These 40 HP units supply 15 psi. steam for heating. Simplicity of operation and controls is an important advantage.



- Choice of Fuels:
  Light Distillate—Natural Gas—Manufactured Gas—Combination Oil and Gas.
- Choice of:
  Mechanical Pressure Atomizing Oil Burner—Pre-Mix Gas Burner—Combination Oil and Gas Burner—All Designed and Built by O & S.
- Simple On-Off and Low-Fire Start Burners.
- Small and Popular Middle-Range Capacities.
- Selection of Automatic Operating and Safety Controls.
- Quick Change from Fuel to Fuel.

O&S

Powermaster®

PACKAGED AUTOMATIC BOILERS

ATOMS IN ACTION

CASH ON THE BARREL-HEAD to the extent of $2,500,000 has been plunked down by a group of 26 firms tied together by a "Memorandum of Understanding" with express interests in the "release and utilization of heat from the fission process for the economical production of electric power." Led by Detroit Edison and Dow Chemical, the group has contracted with the AEC to go beyond paper-study stages and get into actual physical development. Among those in the group are Vitro, United Engineers, Southern Services, and Gibbs and Cox.

ALSO PAYING the bill for a study program is American Machine and Foundry; AMF is interested in equipment and machinery for industrial nuclear power plants and in low-power reactors for special purposes. Babcock and Wilcox is also paying the way for a new survey independent of its previous commitments; admittedly, B & W "is looking forward to the time when it can assume a position as an equipment supplier in the nuclear power business."

A SOBERING NOTE though is sounded by Dr. Ernest O. Lawrence, director of the University of California Radiation Laboratory. He reminds that "although we have extracted energy from the atom, we are still far from an understanding of the forces and processes that govern the atomic nucleus." But the notices keep arriving announcing new contracts with the AEC in which private industry is being committed to the early spade work of the atomic energy business. Bendix Aviation has signed to do a preliminary study on the role of private industry in atomic energy with emphasis on reactors and utilization of fission products; they'll also look closely at mobile reactors.

THERE IS NO DOUBT about our technical ability to make electric power from the fission of uranium, according to Henry D. Smyth, member of the AEC. The definition of success, though, is to bring down the cost of nuclear power to 8 mills per kilowatt-hour; to be widely competitive, atomic power would have to get down to 4 to 7 mills per kilowatt-hour. This is within the realm of possibilities according to already existing estimates. Depending on how the costs of fossil fuels go within the next few decades and depending on the success met in practice by reactor development engineers, Smyth thinks that nuclear power will be supplying 2 to 10 percent of our power by 1975. If other fuels rise in cost, nuclear power will come on the lines somewhat faster.

WASTE DISPOSAL is being studied with a view to minimizing the amount of hot residue that must be disposed of. Radioactive wastes are biologically concentrated and the resulting sludge is burned and dried.

HOT CONCRETE is made by mixing cement and radioactive liquid by-products from a uranium reactor. The resulting slug is proving an excellent source of radiation for studies in food sterilization. A simple, cheap, and portable equipment for X-raying has been developed using radioactive thulium derived from a heavy water reactor. The entire unit weighs less than 10 pounds and the first one cost only $40; its rays are comparable to a 100,000-volt X-ray machine. It requires no electrical power supply. In addition to medical uses, it has industrial possibilities in determinations of levels and densities of liquids in closed systems.

the Range Finder

DR. GERALD J. MATCHETT

Department of Business and Economics

and

Director, National Center of Dynamic Equipment Policy

Illinois Institute of Technology

CONSULTING ENGINEERS today find that *automation* has become a byword in industry. The rapid strides in automation of the past decade present a two-fold challenge to the consultant. He must be versed in the engineering features of the new machines. But secondly, he must also be prepared to realistically appraise the economic advantages and disadvantages of introducing new machinery into specific production situations.

Meaning of Automation

Automation is sometimes used in reference to any method of operation in which human hands are to some extent replaced by mechanical, hydraulic, or electronic handling devices. Most people who speak of automation today speak of it in this sense. If we accept this usage, we may say that automation started with the Industrial Revolution and is continuing at this time. Therefore, "advancing mechanization" might be a more fitting phrase to describe what is taking place today. Even so, modern equipment shows such striking technological advances that some authorities believe a veritable second Industrial Revolution is at hand.

We have now developed methods of operation which completely remove men from the manufacturing process itself, relegating them to maintenance, setup, and supervisory activities. In fact, some people believe that the term automation should be reserved for these methods alone. In this sense, an operation requiring even one man to watch a panel of instruments or to manipulate switches and buttons would be labeled as something less than automatic. Thus, in the strictest sense, automaticity calls for the use of servomechanisms which feed back messages from output stages to input stages of the machine and thereby adjust its operation. Such automatic controls are dealt with in the relatively new science of cybernetics.

Current planning in industry is centered about material handling conveyors, automatic infeed hoppers and mechanisms, automatic clamping and locating jigs and fixtures, automatic transfer and cycling devices, automatic inspection devices, automatic measuring and weighing devices, automatic packaging and marking equipment, and automatic assembly equipment. The greatest pressure for installation of automatic equipment is felt by firms in fields where leading companies have already acted along these lines. Existing or anticipated competitive conditions demand that operating costs be reduced, and automation is proving to be an effective means of bringing this about.

Firms that have converted many of their operations are finding that the quality of their product is improved, valuable floor space is saved, operations are safer, there is less waste, and higher production levels have been attained. These gains have, in a few instances, permitted the revival of almost extinct companies and corporations.

Costlier Maintenance

However, as is usual when old problems are eliminated, new ones have been created. Just as automatic gear shifts, automatic washers and dryers, and automatic defrosters have created problems for the consumer, automation has created problems for the producer. Manufacturers have found that higher maintenance costs must be expected. Some firms have found it necessary to install fairly elaborate preventive maintenance programs; others have assigned maintenance men permanently to "police" portions of the production line. Specialists in hydraulics and electrical circuits have to be trained. All these precautionary measures must be taken to minimize the amount of costly down-time. Depending upon the degree of automation, it has been estimated that breakdowns due to machine failures may cost between $100 and $1000 a minute.

A number of basic problems about automation re-

main to be solved. Still to be determined, for example, is the role electronics will play in future production processes. Most users of automatic equipment prefer mechanical or hydraulic controls. They point out that electronic devices are far too delicate to be used on production lines. Maintaining them calls for electronic specialists who are difficult to obtain, and even these experts encounter serious problems in trying to find and eliminate intermittent troubles. However, others feel that the enormous possibilities in the capabilities of electronic equipment will bring it into increasing prominence in industry.

A controversy also exists over the design of automatic equipment. One school of thought insists that machine designs should be adapted to product design, and the other feels that products should be designed to fit the machines. Manufacturers of production equipment are finding that their customers are demanding machines designed to manufacture the product without necessitating design changes in the product. More often than not, the reason for this is that a great deal of time has been spent on winning public acceptance of a product; there is no inclination to start tampering with its appearance. In the case of a trouble-free product, there is no desire to jeopardize its performance.

Where a product involves both machining and assembly operations, outside suppliers may be involved; changes in design may affect these sources of supply. On the other hand, those who maintain that product design changes should be made believe that existing designs were developed to be put together by men and, hence, do not always lend themselves to automation.

Flexibility

Closely allied to the design problem is one dealing with flexibility of machinery. There is complete agreement that equipment should and can be extremely flexible; this permits quick and economical product changes. A number of plans have been proposed for accomplishing this; a particularly attractive one calls for building automatic production lines around as many standard tools as possible. These would be coupled by automatic methods for loading and unloading parts with automatic materials handling equipment.

Several equipment manufacturers have cooperated in designing their tools to permit this type of flexibility. Machine tools purchased from any of these producers can be fitted into the type of line described. The intense desire to incorporate flexibility in the machines has been motivated by a realization that inflexibility in machinery is a deterrent to new product designs.

A great deal of development must be done in the field of tool design for automatic machinery. To date, the emphasis has been placed on development of the machine itself, and little thought has been given to the tools. As a result, special tools have not been designed, and so-called standard tools have not proven to be satisfactory. Down-time is appreciable due to breakdowns stemming from this problem. There is also a definite need for methods which would permit automatic means for inspecting tools for wear; physical inspection by an operator, as now required, is both time consuming and costly.

Future Outlook

Great as the progress of technology has been in recent years, the day of the man-less factory is still far away. Automation has replaced the need for human judgment in some instances, but most operations still must be controlled by human hands and brains. Moreover, automation, as everything else, eventually resolves itself into a problem of economics. Savings must be compared to cost. There are still operations capable of being performed automatically but where automation would involve prohibitive costs.

Automation often can be adopted and installed by degrees. The engineer can start with small projects and expand by converting additional operations and processes at a later date. However, at all times, the effects of partial automation on the over-all production line must be taken into consideration. There have been situations in the past in which making a portion of the line automatic created an unbalance in the flow of work through subsequent work stations. It was only after compensating changes were made that automation proved profitable under these particular conditions.

It is important that the capabilities and limitations of advanced mechanization be known to the consultant. The effects of automation can be evaluated only in light of a given operation or process. Correct decisions can be reached only by a thorough analysis of the firm's product, its present and future level of operations, available automatic machines, cost of installation, and resultant savings. ▲▲

quotes –

Science has a vital role in our Nation's security and growth. During the past half-century, it has brought about a vast transformation in industry, in agriculture, in medicine, in transportation, and in communications. Military science has been revolutionized by technological development. The impact of science is increasingly felt in every field of public policy including foreign affairs. All that has been brought about through a combination of vision, initiative, business enterprise, a strong educational system, and the dedicated enthusiasm of the scientific community.

President Eisenhower

the Legal Aspect

MELVIN NORD

Consultant in Legal and Technical Problems
Registered Professional Engineer
Chemical Engineer
Patent Attorney

IN ORDER that two parties may come to an agreement of some sort, it is generally necessary that one party make an offer to another person, and that the latter accept the offer. The offer and acceptance together must add up to an agreement between the parties in order to create a contract. Suppose a complete outsider to a transaction should ask Party A, "Would you sell your property for X dollars?" and Party A says he would; suppose the outsider then asks Party B, "Would you buy Party A's property for X dollars?" and Party B says he would. This is not an agreement between Parties A and B, even though there has been mutual assent to the same proposition. Party A never offered to sell his property to Party B for X dollars, and Party B never accepted Party A's offer, so there is no contract.

What is an Offer?

The essential nature of an offer is that it is a promise, conditioned on a specific act or promise of another party. It may be a promise to do something, to refrain from doing something, or to cause a specific thing to happen. The words of the offer need not necessarily be words of promise, so long as they imply a promise. Thus, the words "Ham and eggs" spoken to a waitress in a restaurant imply a promise to pay the price of the ham and eggs if they are served. The "offerer" is at liberty to invent any kind of offer, with any kind of conditions he wishes, since no one is bound to accept the offer.

In order to be capable of ripening into a contract, however, the offer must be sufficiently definite that a court would be able to understand what the offerer has promised to do. If the time of performance is not specified, the courts will not hold the offer to be too indefinite but will generally say that a "reasonable" time was implied. A contract for employment for an unspecified time will generally be held to be capable of termination by either party whenever he wishes. The same is true about prices or wages as is true of time—that is, a "reasonable" price or wage will generally be implied if this is left open in the offer.

What is reasonable is a question of fact for the jury to determine. An offer to build a building, without plans and specifications, would be too indefinite to be capable of ripening into a contract. But a contract to sell all the output of a given plant, or to buy all the requirements of a given product for a given business, will be held to be sufficiently definite.

In order for an offer to be effective, it must normally be communicated to the "offeree." Otherwise the offeree is in no position to accept it. The only exception is when the offeree doesn't actually know of the offer, but acts as if he did and accidentally accepts the offer. This will lead to a contract even though the offer was never actually communicated to the offeree because of the "objective" rule. Aside from this exception, however, an offer is not effective unless and until it reaches the offeree.

While an offer is generally made to a particular individual, it also may be made to a group or even to the public at large, as in offers of rewards. Such an offer is ineffective unless the offeree actually knows of its existence before he does the required act.

Negotiations and Offers

It is very important to distinguish between offers and preliminary negotiations. Many times the opening remark by one of the parties is not an offer, but an invitation for the other party to make an offer. For example, the rule is that an auctioneer invites offers, rather than makes offers of his own. He does not offer to sell to the highest bidder (unless he specifically says so) and he can therefore withdraw the item at any time before he says "Sold." The same is true of advertisements for bids by government bodies. These are not offers, but invitations for others to make offers. Even if the charter of a city requires that contracts be awarded only to the low-

est bidder, the city can decide not to award a contract at all.

Another case in which preliminary negotiations must be distinguished from an offer is the case where the parties intend to "write the contract down later." If this is merely an "agreement to agree" in the future (as it usually is), there is no contract. But if all the terms of the contract have already been agreed on, and writing them down is regarded as a mere formality, then the contract exists even though it may never actually be written down.

Termination of Offers

When an offer is rejected, it ceases to exist altogether. The offeree cannot "revive" it by changing his mind. In many cases, an attempted acceptance of an offer turns out to be a rejection accompanied by a counter-offer. This happens when the offeree varies any of the essential terms of the offer in his reply. For example, suppose Party A offers to sell 1000 tons of steel to Party B at a fixed price, and Party B says, "I accept your offer. The price is fine, but I only want 800 tons." This is not acceptance. It is a rejection and a counter-offer by Party B.

Since an offer is not normally in itself a contract, it can be revoked by the offerer at any time before it has been accepted. The revocation is effective, though, only when it is received by the offeree.

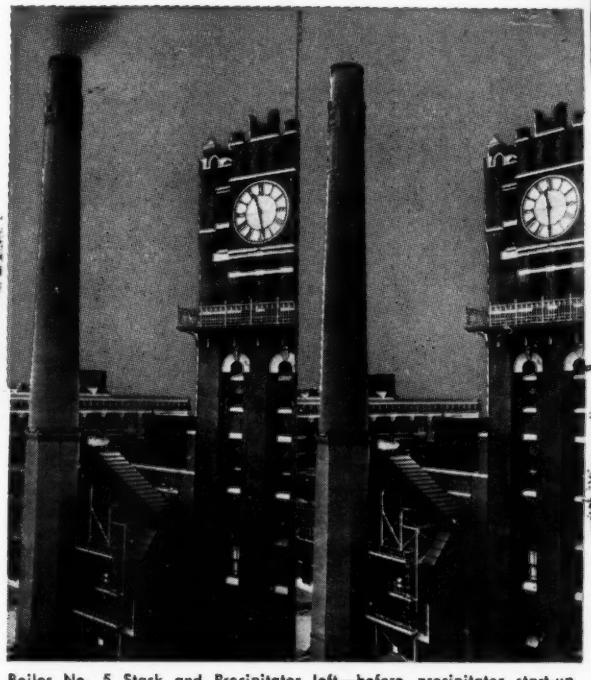
Some offers, however, are contracts. An option is a contract in which the offerer promises to keep the offer open for a certain length of time, and the offeree gives a consideration for this promise. Such an offer cannot be revoked by the offeree. In an option, the offerer is bound while the offeree is free to decide whether or not to accept the offer. This is one way of showing the invalidity of the commonly expressed belief that, "Either both parties are bound or neither is."

An offer may lapse because the time specified in the offer has passed, or because a reasonable time has passed if the offer did not specify any time. It is also held that an offer lapses when the offerer dies. This may be tough on the offeree if he accepts the offer without knowing the offerer is dead, but the rule is well settled nevertheless. Loss of legal capacity of the offerer (say by insanity) also has this effect of causing the offer to no longer exist.

An offer also lapses upon the occurrence of a condition in the offer. For example, if Party A offers to sell certain property to Party B at a fixed price "unless someone else makes a higher bid within 10 days," the offer automatically lapses if someone does make a higher bid within 10 days (provided the offer had not already been accepted by B before the higher bid was made).

Also, the destruction of something essential to performance of the contract will terminate an offer. Thus, if a house is offered for sale and it burns down, the offer terminates at the same time the house does.

Less dust for St. Louis housewives...



Boiler No. 5 Stack and Precipitator left—before precipitator start-up right—precipitator in operation [boiler load 200,000#/hr.]

Anheuser-Busch leads the way with AEROTEC Electrical Precipitators

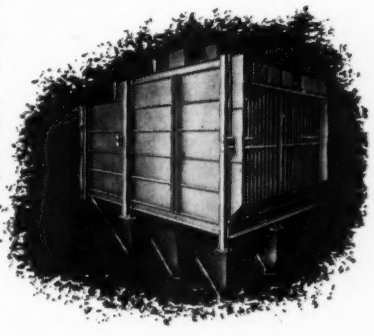
The brewers of famous Budweiser Beer know the importance and value of good public relations. Not content with just meeting local requirements for dust control, the Company sets the pace for air-pollution control in St. Louis.

Together with an existing mechanical collector, the first of five Aerotec Electrical Precipitators at Anheuser-Busch *is collecting 2000 lbs. of dust every 60 minutes from a single stack.*

The remaining four electrical precipitators are about to be placed in service, and dust emission will be less than one fourth of the maximum allowable under the requirements of St. Louis' dust ordinance.

Reasons for Aerotec's higher collecting efficiency are:

- Pocket-type collecting electrodes prevent precipitated dust from re-entering gas stream.
- Exclusive flat high voltage plate presents a field of uniform maximum intensity for most effective precipitation.



For other advantages of Aerotec Electrical Precipitators write or call our project engineers—Thermix Corporation.

Project Engineers **THE THERMIX CORPORATION** Greenwich, Conn.

(Offices in 38 Principal Cities)

Canadian Affiliates: T. C. CHOWN, Ltd., Montreal 25, Quebec; Toronto 5, Ontario

Manufacturers

THE AEROTEC CORPORATION

GREENWICH, CONN.

An Idea Mine

. . . for Consulting Engineers

HYMAN OLKEN
Arndt, Preston, Chapin, Lamb and Keen, Inc.

CE exclusive

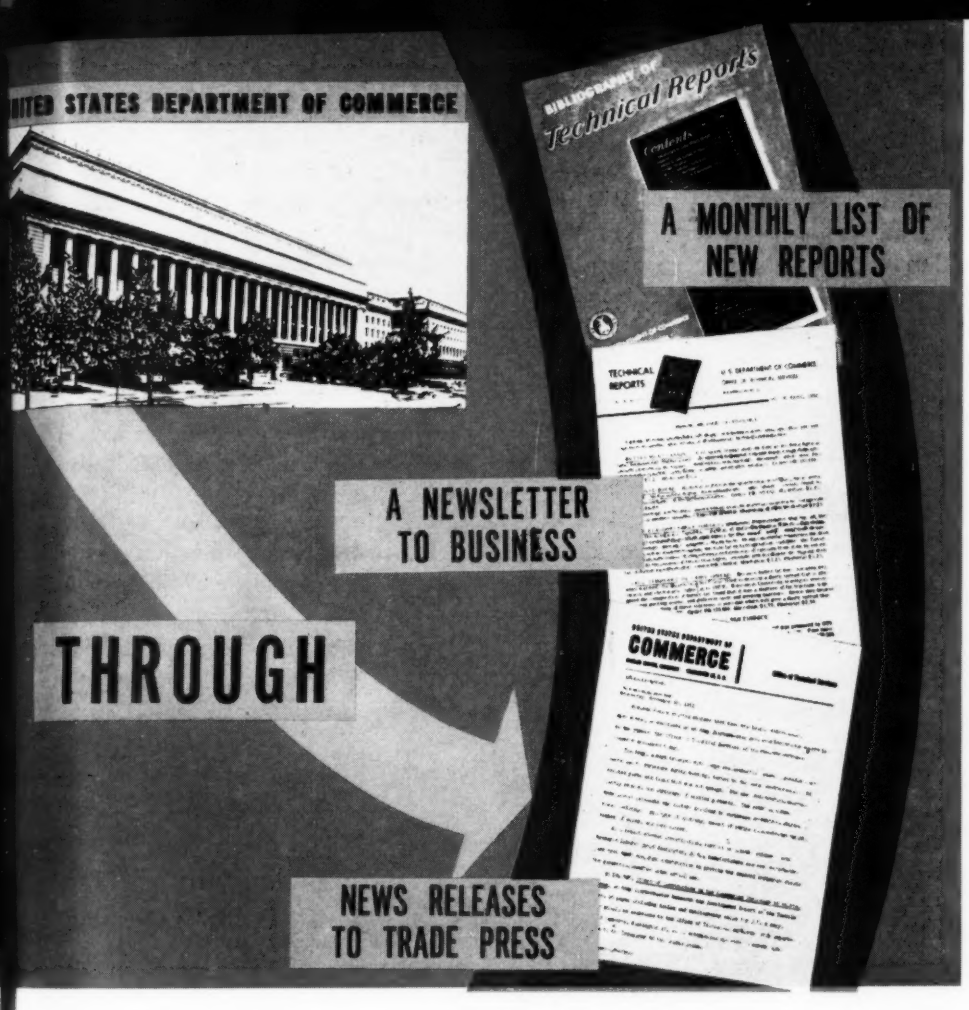
A BYPRODUCT of the federal government's vast expenditures for research is a growing stockpile of publicly available government research reports. This stockpile already holds well over 250,000 documents and thousands more are added to it every year.

The federal government spends about $2.2 billion each year to support research and development projects. Among these projects are many of great value to consulting engineers. A considerable number of the projects are not directly related to national defense, so the reports on them do not fall under any security restrictions. In addition, many classified reports are constantly being declassified.

The government's research and development projects cover every field of industrial activity. The stockpile of government research reports is, therefore, a veritable mine of ideas. As industry's technological advisors, members of the consulting engineering profession are the ones who can best help industry derive the greatest benefit from this report collection. Whereupon consulting engineers will want to know where the idea mine is located, what is in it, and how to use it.

A unit of the Commerce Department called the Office of Technical Services (OTS) was assigned the task of collecting the vast amounts of technical material captured by our Armed Services at the end of World War II. The OTS is to make this information available to American industry.

In addition to being custodian of the captured foreign technical material, OTS now receives automatically nearly all government research reports as soon as they are declassified. Also included in the OTS collection are all the research and development reports issued by the government's World



FLOW CHART (LEFT) SHOWS HOW VAST NUMBERS OF REPORTS FROM MANY SOURCES ARE FUNNELED INTO THE OFFICES OF TECHNICAL SERVICES, THUS BUILDING UP AN IDEA MINE FOR USE OF CONSULTING ENGINEERS..

War II research agency—the Office of Scientific Research and Development. In addition, OTS now functions as the sales agency for the unclassified publications of the Atomic Energy Commission.

Catalog to the Mine

The offices of OTS are in the Department of Commerce Building in Washington, D. C. In these offices OTS keeps a card catalog of all the research reports in its collection; in this catalog all reports are indexed by title, by subject, and by author. The reports themselves are all stockpiled in the Library of Congress Annex, in the Library's Publication Board Project. A card file of all these reports, listed by OTS serial number only, is also kept in the newspaper reference room (the Chaucer Room) in the Library of Congress Annex, in downtown Washington, D. C.

Copying Facilities

In addition to the OTS report collection, the Library of Congress' PBP is also custodian of technical reports of the National Advisory Committee for Aeronautics and other government research agencies. By arrangement with these agencies, the PBP has set up photostat and microfilm services through which it furnishes (practically at cost) copies of any one of the unclassified reports in its custody. The unit's average monthly volume (about $8,000) for photostats and microfilms indicates that industry has already begun to appreciate and use the wealth of raw material here.

Thus, OTS is the clearing house responsible for collecting the government's research reports and getting them out to industry. The reports are kept for OTS by the Library of Congress, in the Library's Publication Board Project. To search through the report collection for material on a particular subject, by a particular author, or under a particular title, just search the card catalogue located in the OTS office in the Department of Commerce building. To study the reports themselves, go to the Library of Congress Annex.

New Structure Analysis

To cite practical examples, consider the new technique for enabling structural engineers to compute stresses and deflections in beams. Already well established was the technique of producing scale models of the desired structure, applying appropriate loads, and then measuring the resulting stress and deflections. These were then "scaled up" to arrive at the stress and deflection values for the full-size structure. But of late, a new approach has been added by borrowing a leaf from the mechanical engineer's book.

Mechanical engineers have long followed the practice of translating machine elements into anal-

ogous or equivalent electrical circuit components. Using well-developed methods of electrical circuit analysis, they can determine the electrical conditions at any point in the equivalent circuit. Translating these back into the corresponding stress and deflection values gives the mechanical engineer the stresses and deflections on any desired element of the machine.

Valuable Asset

What a valuable asset it would be to the consulting structural engineer if the equivalent circuit could also be used as a tool for pre-testing structures! No longer would he have to put up with the cost and delay of building models. The structural consultant who used this tool would gain all the great time-saving advantages made possible by the modern electronic computers that can handle circuit analysis. Well, the tool has already been developed and is presented in a government research report entitled "Introduction to Electrical-Circuit Analogies for Beam Analysis". Furthermore, the report presents this new tool in a manner so that the structural engineer can readily master its use.

A group of Canadian government research reports point out which are the right fuels to use in gas turbines to assure long turbine life, and how to specify such fuels. The material offered in such reports is indicated by this brief description of gas turbine fuels report:

"Sodium contained in gas turbine fuels was suspected by the Canadian scientists as being vanadium's fellow partner in corroding gas turbine blades. So in another phase of their study they investigated the occurrence of sodium in gas turbine fuels and how it could be removed".

The bulk of the reports added to the government research report stockpile are announced to the public in a monthly publication of the OTS called the *Bibliography of Technical Reports.* Each month's issue of this 40-page publication will list some 300 to 400 reports—giving the source of each, the date, title, and an author's abstract, and where available.

The procedure commonly followed by those prospecting in this idea mine is as follows: review the OTS *Bibliography* each month to learn of the latest reports on a subject, and consult the card catalogue at OTS for lists of earlier reports on that subject.

Although very widely practiced, this is far from the most effective procedure for digging out the wealth of problem-solving aid this idea mine contains for the consulting engineer. A technique by which the consulting engineer can recover a much higher percentage of the raw material comprises two steps. First, study the original reports. Only an inkling is given by the report title in the *Bibliography* as to the contents of many large and valuable reports. Very often the author's abstract, when provided, is designed to inform only other workers in his field; thus it omits mention of much valuable material the report may contain, or presents the contents in a way that does not indicate its many possible areas of application. There is no substitute for spending time at the Library of Congress Annex to study the research reports first hand.

Watch a Series

Second, a long string of reports is very often the clue that another report is coming out which provides the key for converting all the research information piled up in the series into practical industrial advances. To illustrate, consider the chain of reports by the Naval Research Laboratory on the development of synthetic lubricants. Starting about 1945, there appeared a string of report titles related to this Laboratory's basic program of research into the composition, properties, and preparation of synthetic lubricants; each report detailed a considerable advance in the field. The string of well over a dozen reports was listed at various times in the *Bibliography.* Finally came PB Report No. 111118 entitled "Present Problems and Future Trends in Lubrication". It summarizes all the advances developed in this research program, the problems still to be solved, and the channels or approaches to be followed in solving them. All this is contained in its 24 pages, and is available at the price of 75¢ per copy.

The government's expenditures of billions for scientific and technical research every year is piling up a mine of ideas for new industrial processes, improved products, and better production techniques —all of which the consulting engineer can cash in on to solve his client's problem. But it takes constant follow-up to fully extract the material.

CE quotes –

Power costs are generally higher in Europe than here and are still higher in some other parts of the world . . . In Japan, the estimated cost of power is 20 mills per kilowatt hour, probably the highest of any industrialized country. The best figures I can get as examples of power costs in Europe are: For the United Kingdom, about 7 mills or more per kilowatt hour; for Belgium, 9 to 10 mills and probably about the same for France. Since the last few mills will be the hardest to cut from our nuclear power cost, it is evident that nuclear power may well be competitive with these foreign costs considerably before they can compete with our own costs of 4 to 7 mills per kilowatt hour.

Henry D. Smyth, Member
U. S. Atomic Energy Commission

THE HOWE WEB MEMBER SYSTEM IS USED FOR FLAT TRUSSES WHEN THEY ARE SUPPORTED ON CORBELS ATTACHED TO THE COLUMNS, SINCE THE STRESSES IN THE WEB MEMBERS ARE LESS THAN IN OTHER TIMBER TRUSS DESIGNS.

Engineered Timber Construction

New Ideas for an Old Material

WILLIAM R. GANSER, JR., Structural Engineer
Timber Engineering Company

W. R. Ganser, Jr. delivers frequent lectures on the subject of engineered timber construction at architectural and engineering colleges. Since joining the staff of Timber Engineering Company in 1949, he has been engaged in the development and testing of timber roof structures. Ganser holds a Bachelor of Science degree and a Civil Engineering degree from Lafayette College, and is a junior member of the American Society of Civil Engineers. Prior to joining Timber Engineering Co., he was associated with the harbor contracting firm of John N. Spooner & Sons.

EACH YEAR spectacular wood structures set new precedents in engineered timber construction. Foremost among the structures built in 1953 was the 28-acre warehouse at Franconia, Virginia, built for Parr Warehouse Company and leased to the Government Service Administration. Spanned by 773 Arch-Teco timber trusses, and using over five million board feet of lumber, it is one of the nation's largest engineered timber warehouses. The clear-span roof construction used in this building will permit maximum utilization of its million-plus square feet of floor space. Completion of the structure,

THE PRATT SYSTEM HAS THE ADVANTAGE OF KEEPING THE LENGTH OF COMPRESSION WEB MEMBERS TO A MINIMUM.

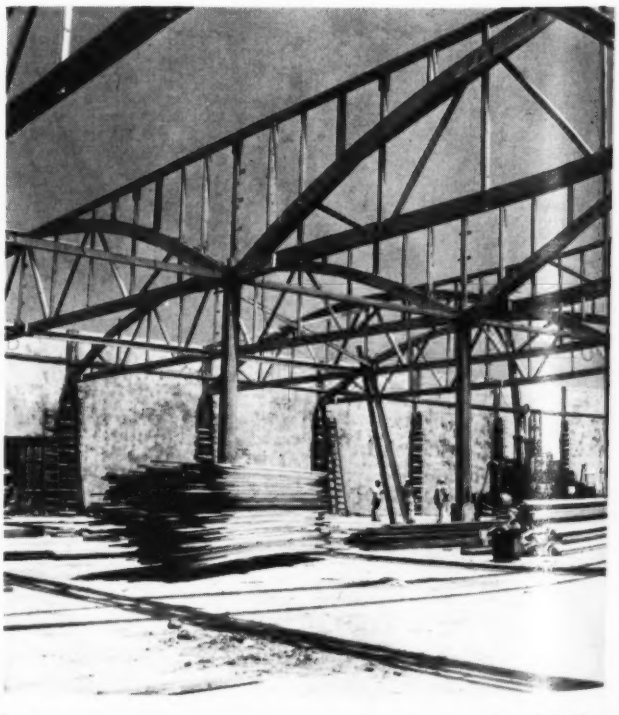
ready for occupancy, required less than one year from ground breaking.

Although clear-span timber truss designs generally fall into three basic classifications, there have been many special designs and modifications of standard designs developed to meet unusual conditions. In selecting the truss design to be used, such factors as architectural appearance, type of roofing material, method of support and column framing, and relative economy must be taken into consideration. The method of fabrication should also be considered, particularly with respect to glued-laminated truss members which are not generally suitable for field fabrication by the average contractor.

Other factors being equal, the labor costs for fabrication and the relative efficiencies in the use of material offered by the various truss types are prime considerations. Although a precise relationship of relative economies between the basic truss types cannot be defined, the different truss designs do vary in their theoretical load-supporting efficiencies. In the order of their theoretical efficiency, the three basic truss types can be classed as bowstring, pitched, and flat.

Bowstring Trusses

For more or less uniform loads, which are usually assumed in roof construction, an arch in the shape of a parabola is theoretically the most efficient, since only direct stress could be developed in the arch and in the tie member, and there would be no need for a larger arch section to take care of bending moment, and no need to introduce web members to lessen the amount of bending in the arch. Because most structures must be designed for some unbalanced load,



ARCH-TECO TRUSSES, OVER 70 FEET LONG, WERE USED IN THE PARR WAREHOUSE AT FRANCONIA, VA.

however, web members are desirable, and a circular arch is simpler to fabricate than the parabolic shape. Thus, the widely used bowstring has a top chord in a circular arc as well as web members which are designed to hold the top chord to a reasonable size.

Since bowstring trusses are usually analyzed as though the top chord were in a straight line between panel points, the top chord can be laminated and glued to an actual circular or curved shape, or it can be constructed of sawn timbers laid to the curved pattern with or without sawing the top surface to the curvature. Glued-laminated members not only permit smaller sizes, but eliminate or lessen the need for maintenance required for sawn members which season in place. Because of the labor involved in laminating, however, they are more expensive.

Nailed-laminated top chords—more suitable for field fabrication than glued-laminated members—also are used for bowstring trusses. Their efficiency is considerably less than either glued-laminated or sawn members of the same size, but they are suitable where the amount of nailing is properly designed and specified to guarantee the required strength of the built-up section.

Bowstring trusses may be built up to provide the appearance of either a flat or a pitched truss—therefore they are probably the most flexible of all truss types. It is important that proper bracing be provided for that portion of the normal top chord which is not laterally supported by the roof framing.

Pitched and Flat Types

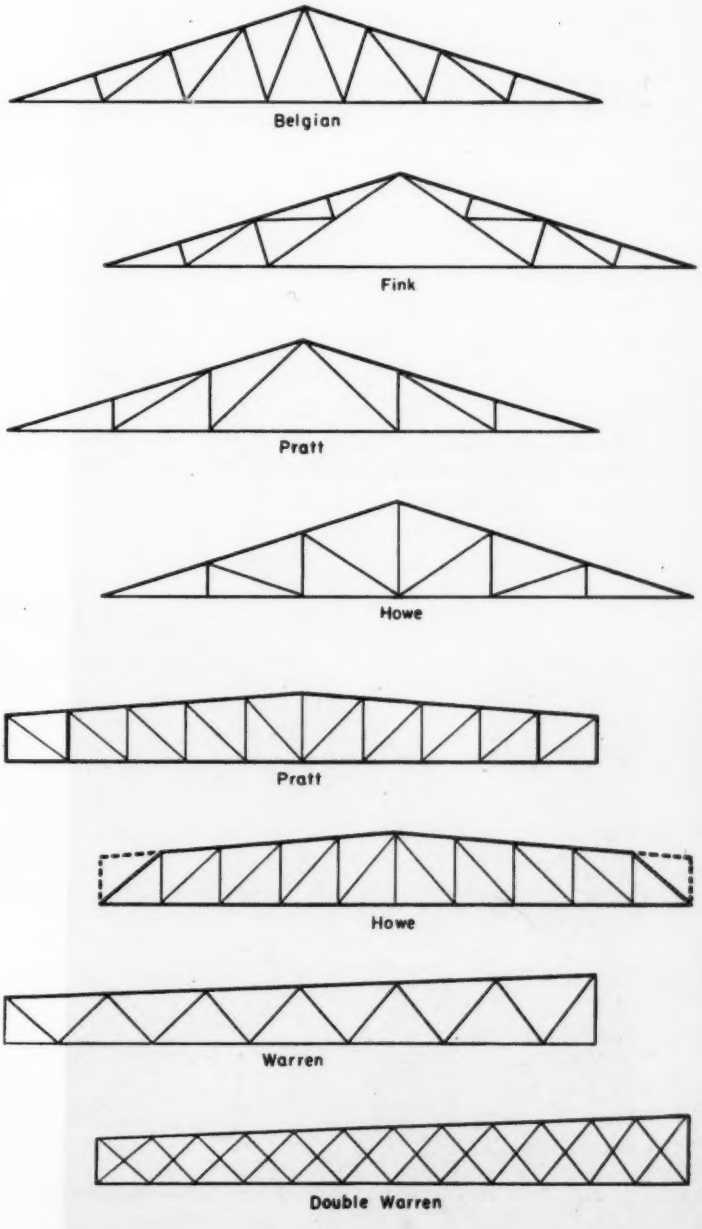
Some of the theoretical advantages of a bowstring also are found in the pitched type truss. Like the bowstring, a portion of the load in the pitched truss is transferred to the supports directly through the top chord members, and therefore need not be carried entirely by the web members. In average spans, pitched trusses have the economical advantage of permitting the use of sawn timber without special sawing or fitting to curvature, and of being easy to lay out and fabricate since, as in the bowstring truss, the web member connections are usually simple and much less complicated than for a flat truss.

Although the flat type truss designs are less efficient than either the pitched or bowstring types, a relatively flat roof surface is sometimes desired—particularly for multiple spans. For lateral bracing and column connections, they have the advantage of providing a knee brace effect since both the top and bottom chords may be attached to the columns. Web member stresses for the normal truss proportions are considerably higher for the flat design than for pitched or bowstring trusses, however, and the web connections are more complicated.

The so-called cambered or raised-chord trusses, with the bottom chords substantially above the level of the supports, are frequently used for reasons of appearance or added clearance. Typical examples are crescent trusses of a bowstring type, cambered pitched trusses of Howe, Pratt, or Fink web systems, and scissors trusses. Unless cambered trusses are analyzed as arches, and fixity or resistance to horizontal thrust provided at the support, the effective depth-to-span ratios of simple trusses should be maintained.

Many other types of trusses and combinations of standard types offer advantages for special considerations. In general, the same recommendations for proportions and spacing that apply to the general types also apply to the special trusses. Typical combinations of the basic designs are bowstring-flat or

FIGURE 1 — COMMON WEB MEMBER SYSTEMS FOR PITCHED AND FLAT TIMBER TRUSSES.



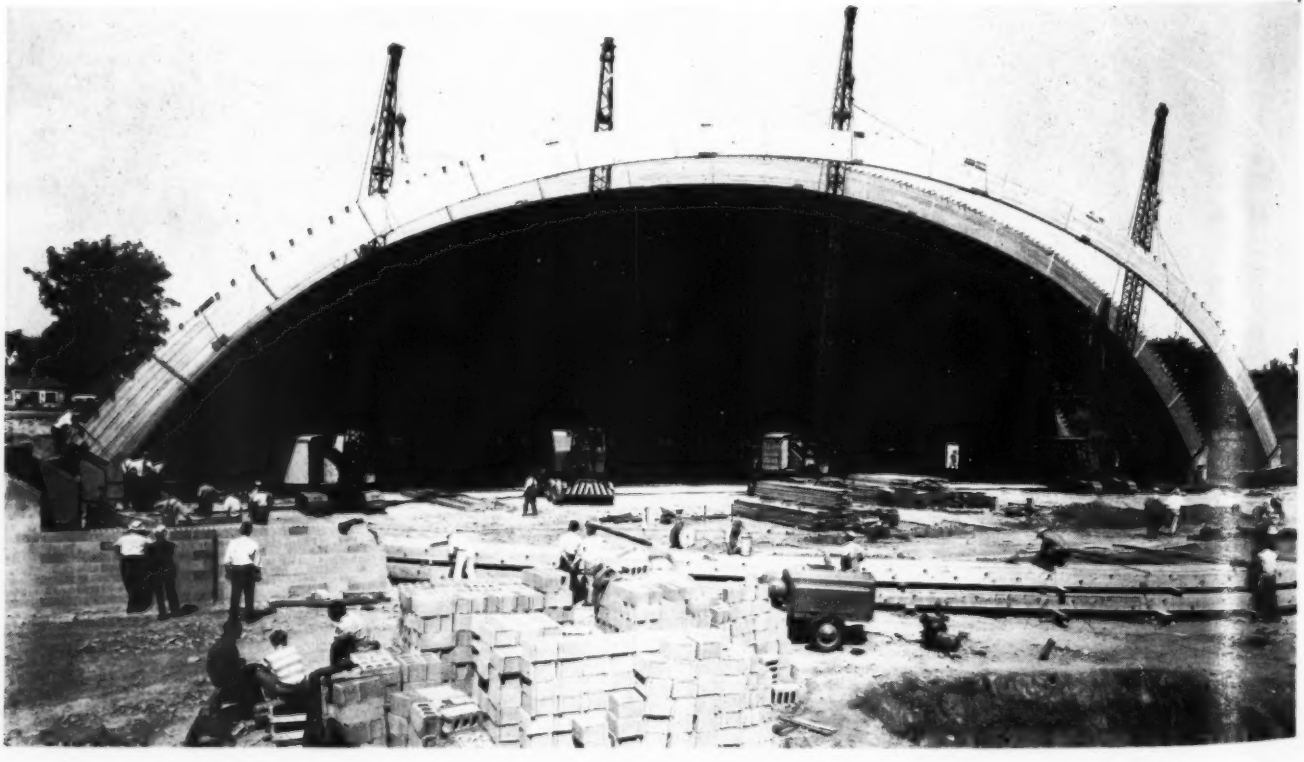
WARREN TRUSSES FORM THE 120-FT CENTER SPAN OF THIS MODERN CREOSOTED BRIDGE IN WASHINGTON STATE.

pitched-flat, used to provide drainage to the outside walls on two-span structures. Special types include the common sawtooth truss, cantilevered trusses, and inverted trusses.

Truss Proportions

Since the ratio of working stresses to modulus of elasticity is higher in timber than in steel, and since there is inelastic deformation in most mechanical timber connections, larger deflections may occur with timber than with steel when built to the same proportions.

The ratios of effective depth-to-span, shown in Table 1, are recommended as being satisfactory on the basis of experience. In general, the larger the span, the more desirable it is to use deeper trusses. While trusses of lesser depth than these may be used satisfactorily, special attention should be given to



210-FT GLUED-LAMINATED, TWO-HINGED ARCHES ARE BEING USED FOR THIS STADIUM IN GRAND RAPIDS, MICH.

possible larger deflection and secondary stresses.

Deflection of free span timber trusses is usually well within acceptable limits for plaster, however, special attention must be given to see that the natural deflection does not interfere with auxiliary framing. Thus, ample clearance should be provided between trusses and so-called non-bearing partitions or plate glass windows, and provision for adjustment in the level of the hangers should be made for doors or machinery hung from the trusses where deflection may interfere with proper operations.

It is desirable to use the fewest possible number of panels for a truss while keeping member sizes reasonable. This will mean fewer members to handle, fewer joints to fabricate and assemble, and theoretically improved performance.

The number of panels is usually determined by the reasonable top chord sizes rather than by any certain number of panels for a given type of truss. For material of two-inch to four-inch thickness, panel length will usually fall in the range of six to ten feet. Thus, a symmetrical truss having a 30-ft span would probably have four panels while a truss of 40 feet might have either four or six. Similarly, a truss of 80 ft span would have eight or ten panels.

FLAT TRUSSES WITH A DOUBLE WARREN WEB SYSTEM ARE USED TO SPAN THIS 105-FT WIDE WAREHOUSE.

Web Systems

Although theoretical performance and economy do not vary widely between the various web systems commonly used with timber trusses, each web design does have its own advantages. Generally web systems which require framing more than two members to the same joint should be avoided unless design stresses are light, or wood or steel gusset plates are used.

The web member system most used for the bowstring truss is of a Warren type for relatively small spans, and Warren with vertical members added to keep the top chord panels to a reasonable length for the longer spans.

TABLE 1 — RATIOS OF EFFECTIVE DEPTH-TO-SPAN FOR TIMBER TRUSSES

Type of Truss	*Depth-to-Span Ratio*
Bowstring	1/6 to 1/8 (radius equal to span)
Pitched	1/5 to 1/6
Flat	1/8 to 1/10 (min. slope 1/4" per foot)

Web systems commonly used with pitched trusses include Belgian, Fink, Pratt, and Howe. Each style offers special advantages, depending upon such factors as the auxiliary framing and joint system to be used. For normally proportioned trusses, the Belgian system will provide more nearly balanced web member stresses than the other three, thus frequently simplifying joint details.

On the other hand, the Pratt or Howe system may permit simpler details when the smaller stress in the vertical web member is the critical stress. These web systems also are desirable where monitors or other special framing is installed above the top chord or below the truss, since the vertical web members can be extended to form part of the framing.

The Fink web member system is recommended where the length of compression web members toward the centerline of the span is such that unreasonable sizes of members would be required with the other pitched types because of the larger slenderness ratios. However, the critical web member stresses are higher than with other web member systems, and one joint involves three web members at the same point. Both conditions make the connections more difficult and the system less desirable.

Web member systems frequently used for flat

—Continued on page 80

60-FT CAMBERED TRUSS, BEING POSITIONED DURING CONSTRUCTION OF A TABERNACLE AT SALINAS, CAL.

SERIOUS AIR POLLUTION CAN OCCUR IF ELECTRO STATIC DUST COLLECTORS ARE TURNED OFF AT NIGHT.

Air Pollution Control

WILLIAM G. CHRISTY
Consulting Engineer

CE exclusive

William G. Christy is probably the outstanding authority on air pollution. Since 1926, when he helped pioneer and acted as Executive Secretary, Citizens' Smoke Abatement League of St. Louis, Christy has organized, administered, and been consulted on air pollution control programs in many parts of the country. An ME graduate of Cornell University, class of 1911, he is well-known in the professional engineering societies. Mr. Christy returned to his private consulting practice after serving as Chairman of the Smoke Control Board, New York City, from 1950 to 1952.

THE MOVEMENT TO ADOPT legislation to control smoke is nearly 700 years old. Bituminous coal was discovered in England early in the 13th century. It was first found along the shore and was called "sea cole" to distinguish it from charcoal. By 1257 it had come into common use. In that year, Queen Eleanor, wife of King Henry III, removed from Nottingham to Tutbury Castle on account of the "unendurable smoke from sea cole". The first smoke legislation came in 1273 when Parliament passed a law prohibiting the burning of sea coal in England.

Despite all laws, the use of bituminous coal became more widespread. In 1306, a smoke abatement association, the first on record, was organized in London. Still, smoke continued to increase and so did the agitation to eliminate it. King Edward I, in 1307, appointed a "Commission of Oyer and Terminer" to enforce the anti-smoke laws. This was the first of many royal commissions and select committees of Parliament appointed to investigate the smoke nuisance.

Smoke in America

In this country, the earliest known court record involving smoke was a private suit at law in St. Louis in 1864. A man named Whalen sued his neighbor, Keith, for damages caused by a smoking chimney. Whalen was awarded damages of $50. On appeal, the Missouri Supreme Court upheld the

decision and adjudged smoke to be a nuisance.

In 1874, the Citizens' Association in Chicago became actively concerned with the smoke problem. Seven years later, in April, 1881, the Chicago City Council adopted the first smoke ordinance in America. Within the next few years, Cincinnati, Pittsburgh, St. Louis, and Cleveland followed suit. Today, some 250 municipalities, together with a few counties and states, have some form of smoke or air pollution legislation.

Forms of Air Pollution

For many years, smoke alone was mentioned in ordinances and the elimination of smoke was the principal activity of municipal smoke regulation bureaus. Reduction of smoke was naturally accompanied by some lessening of soot emissions. (Burning of any fuel, except gas, is followed by some discharge of dust in the form of cinders, fly ash, soot, or fly carbon.) The use of forced draft resulted in the discharge of more solid particles from stacks. This problem became more aggravated when pulverized coal burning was introduced some 30 years ago.

The problem of fumes and odors has become more acute in recent years with the increase of process industries. Many laws now include provisions that limit the discharge of all forms of atmospheric pollution into the open air. Agencies, formerly called smoke abatement, smoke regulation, or smoke control, are now referred to as *air pollution control* bureaus or departments

There are many sources of smoke—other than the burning of bituminous coal—such as: the burning of fuel oil, wood, sawdust, garbage, refuse, tar, pitch, acid sludge, peanut or cocoanut shells, or bagasse. Almost any combustible substance, if not burned in equipment that is properly designed, built, operated, and maintained, may produce smoke. Two of the biggest sources of smoke in New York City are the burning of fuel oil in heating and power plants and the burning of garbage and refuse in apartment house incinerators.

There is usually no short cut to smoke elimination. The way to stop smoke is not to make any! In other words, correct conditions must be created in the furnace or combustion chamber so that combustion of the fuel is complete. Probably the two most important requirements for complete combustion (assuming that the furnace is of sufficient size and the temperature well above the ignition temperature of any component of the fuel) are the maintenance of the fuel-air ratio and turbulence of the mixture.

The Human Element

After more than 27 years' experience in smoke and air pollution control work, it is the author's contention that 75 percent of air pollution can be attributed to carelessness. Even with the best equipment and the plant designed for the fuel being burned, excessive smoke can be produced. Sometimes it is the fault of breakdowns or mechanical failures, but more often it is due to the failure of the human element. Control of air pollution is a highly technical problem but also an intensely human problem.

The nature of fuel burning equipment is such that men are needed to maintain and operate the installations. Most plants have load changes—some are frequent and violent. And any disturbance of the fuel-air ratio may be followed by excessive smoke conditions. Automatic combustion control equipment helps eliminate some operating problems, but close supervision is still desirable. Both in operation and maintenance, one small neglected item can start a series of events that will soon show up in the stack discharge.

Proper Firing

There are some types of fuel burning equipment that are quite sensitive to proper adjustment of fuel and air. A good example is equipment for burning heavy fuel oil. A small piece of dirt, a little sludge from the tank, a change of fuel temperature, a tiny adjustment of a valve, may upset the correct fuel-air ratio and cause dense smoke emission.

Those not directly engaged in air pollution control work are not apt to realize the importance of the human element in this activity. With a hand-fired boiler or furnace burning bituminous coal, the smoke performance depends very largely upon the skill and care of the fireman. With mechanical firing and automatic combustion control, the effect of the human element may not be so obvious—but it is there just the same.

Operation and Maintenance

Careful inspection and periodic maintenance depend on capable and reliable personnel. Even with dust and fume collection the human element plays an important part. There are known instances where electrostatic dust collectors have been turned off at night. It seems that the human element enters into every phase of a successful air pollution control program.

Good salaries and wages must be paid for qualified operators and maintenance men. Unfortunately, many small plants do not pay top wages. This seems to be particularly true of apartment houses in our larger cities; and it is one of the handicaps that face the air pollution control enforcement bureaus in these communities. To keep all equipment in good operating condition and functioning properly requires the constant attention of experienced operators and mechanics.

Along with operation and maintenance, good supervision is very necessary. In the field work of an air pollution control bureau, the effects of good

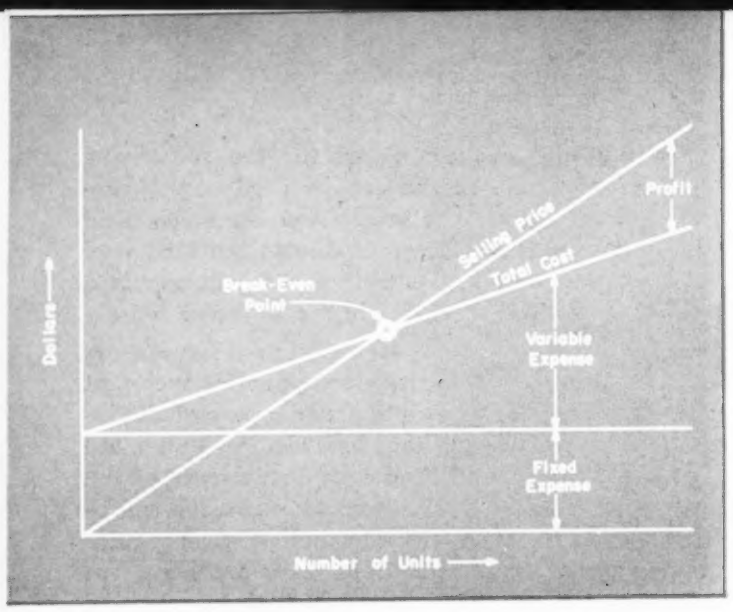


FIG. 1 — CROSSING LINES ESTABLISH THE BREAK-EVEN POINT BETWEEN COSTS AND ADVANTAGES.

The Break-Even Graph

Tool For Consulting Engineers

WILLIAM A. SCHUETTE
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THE BREAK-EVEN graph is a device by which consulting engineers can make exceedingly clear presentations of significant facts to clients; it also simplifies analysis of the supporting figures. This type of graph helps to clarify the engineer's planning; when included in a report to his client, it serves to speed approvals and to make the report easier to comprehend.

The break-even graph basically provides a pictorial presentation of the amortization of fixed expenses. It compares fixed-plus-variable expenses with income or gain. The point where the total cost line intersects the income line is the break-even point, i. e., the point at which the expense has just been offset by the gain. A simple construction of the basic break-even graph is given in Fig. 1.

Fig. 2 shows how the consulting engineer can use the break-even graph to illustrate the analysis of comparative methods. The engineer wants to show his client why he chose a V-belt drive rather than a chain-and-sprocket drive. The atmosphere in which the drive must operate contains heavy concentrations of abrasive dust. Normal lubrication techniques cannot be used because the lubricant would pick up the dust and become a grinding compound.

The engineer knows that both the chain-and-sprocket drive and V-belts will last approximately one year in this abrasive atmosphere. However, at the end of a year the entire chain-and-sprocket drive would require replacement but only the belts would need replacement if the V-belt drive were used. The client is aware of the fact that for this particular application the original cost of the complete chain-and-sprocket drive is less than the complete original cost of the V-belt drive. The engineer wants to prove that the selection of the V-belt drive

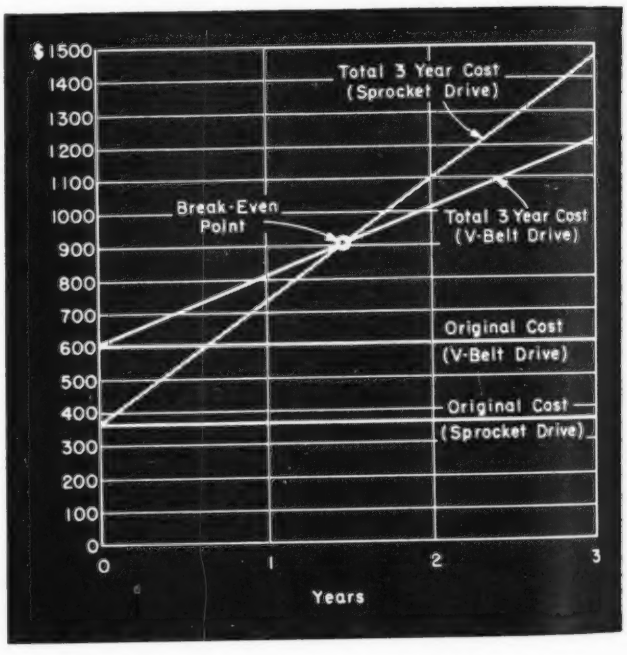


FIG. 2 — GRAPH PROVES ADVANTAGE OF BELT DRIVE WILL COME WITHIN ITS EXPECTED LIFE.

is economically sound. The facts used to support the break-even graph of Fig. 2 are:

	Sprocket Drive	V-belt Drive
Original Cost	$ 368*	$ 600
Replacement Cost		
Yearly	368	203
Total, 3 years	1,104	609

In addition, the engineer finds that the V-belt drive has a maintenance advantage but decides that he will exclude that cost as he cannot establish that the maintenance man will do other work in the time saved. Admittedly the example has been simplified through the omission of such related factors as interest on the investment.

Assume that another client, a small electric utility, has asked a consulting engineer his reason for including feeder voltage regulators in the specifica-

*Prices for examples only.

tions for a proposed system. The engineer can answer with various generalities such as "Everyone uses them." Chances are, though, that he would rather provide specific evidence that the regulator will prove valuable to his client.

In this example, assume that he has the following data available; assume also that the system would have a three-percent voltage drop if the regulators were not furnished:

Fixed Expense	
Original price of regulator	$ 1,400
Cost of installation	500
Total fixed expense	$ 1,900
Variable Expense	
Power loss within unit	$ 35
Inspection and maintenance	100
Total annual expense	$ 135

These costs will be offset by additional revenue from the increased power consumption possible with improved voltages. In improving a three-percent voltage drop at peak load, an annual increase in revenue of about $800 is possible. Plotting this data on a break-even graph results in Fig. 3. The break-even graph shows that the feeder voltage regulator can "pay for itself" out of additional revenues in approximately three years. In addition, the client will provide better service to his customers by maintaining better voltage, but a dollar value on this would be difficult to estimate.

The data required to prepare a break-even graph does not normally require extra research; the figures should be available already if a thorough analysis is being made. Often it will be to the client's advantage to see that a suggested device or procedure is not economically desirable. The engineer can easily show why a proposal was rejected if the data fits into the form of the graph. Naturally, no break-even point will appear if the cost increases at a higher rate than income. An example is hardly necessary; a representative graph is shown by Fig. 4. Lines a-a and b-b diverge and the fixed expense can never be amortized. An unsatisfactory result is also indicated if the break-even point is reached only after an unsatisfactory number of units (or length of time) has been reached. Even in these instances the graph can be a valuable tool, and it quickly shows the product to be undesirable.

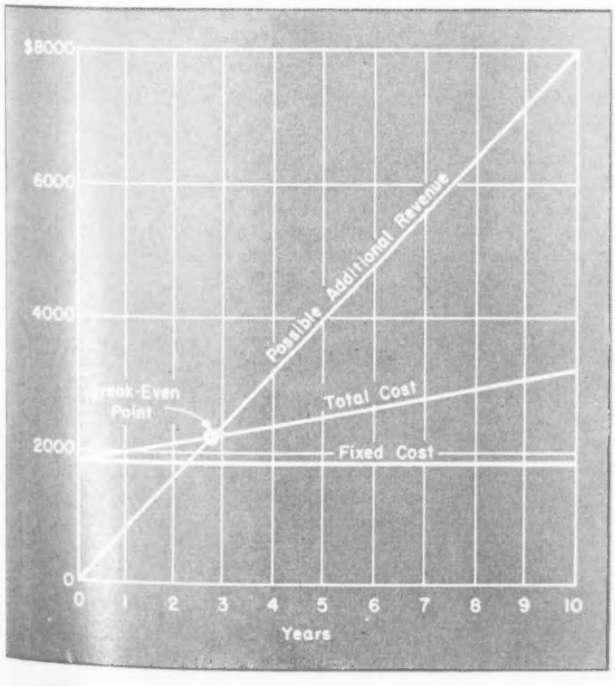


FIG. 3 — GRAPH PROVES REGULATORS WILL PAY THEIR OWN COST WITHIN THEIR EXPECTED LIFE.

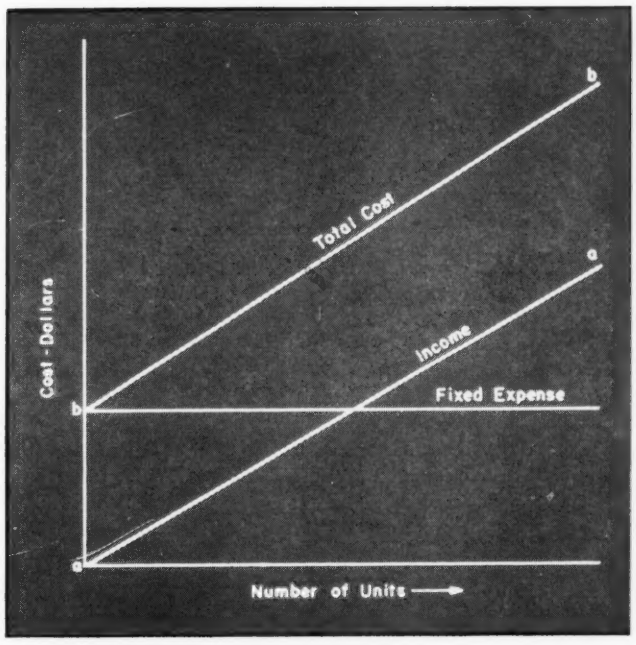


FIG. 4—A BREAK-EVEN POINT NEED NOT EXIST; GRAPH IS A VALUABLE TOOL IN THESE CASES TOO.

Hopper For Crusher

A satisfactory result is shown in Fig. 5; it is based on the following problem. The operators of a stone-crushing plant are investigating increasing the output of one of their crushers. The crusher discharges onto a conveyor belt which is used to load trucks having a five-yard capacity. After making his analysis, the consulting engineer recommends the installation of a hopper and uses the break-even graph to add spice to his presentation of the following facts.

Under the present set-up, the crusher must be started to load each truck and stopped when the truck is loaded. Additional trucking capacity is available without affecting price or profit. Capacity of crusher is 120 yards per hour. Average down-time to allow for change of trucks is 2½ minutes. Profit per yard of stone is 10 cents. Down-time limits crusher output to 60 yards per hour. The use of a

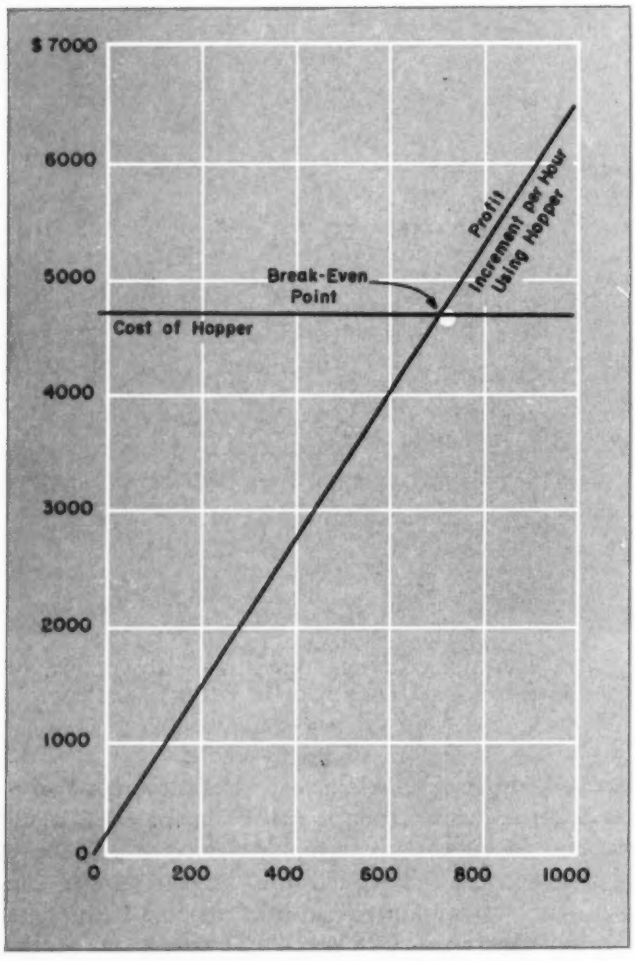


FIG. 5 — COMBINING EXPENSE AND INCOME TO SHOW PROFIT SIMPLIFIES, BUT MASKS DETAILS.

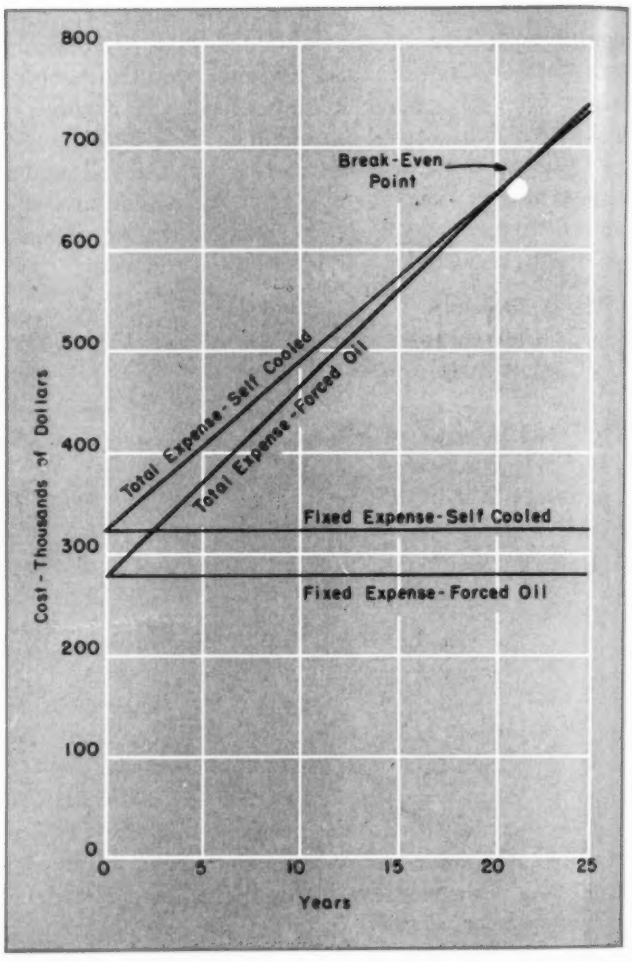


FIG. 6 — THIS AND FIGS. 7 AND 8 SHOW HOW SLIGHT DATA CHANGES SHIFT BREAK-EVEN POINT.

hopper avoids down-time, therefore increases output by 65 yards per hour.

The profit on the additional output would be $6.50 per hour. The client wishes to "amortize" his investment in 1000 operational hours. The costs are:

Price of hopper	$ 2,000
Price of operating gates	400
Additional 40-foot extension to present conveyor belt	2,300
Total fixed cost	$ 4,700

The proper selection of power transformers is an engineer's problem, part of which can be solved and illustrated through the use of break-even graphs. The problem is too complex to permit full analysis here; however, assuming other aspects have been investigated, it now comes down to the final choice between an oil-immersed, self-air-cooled transformer and a forced-oil, air-cooled transformer.

The self-cooled transformer is more efficient but its initial cost is higher. The problem is to determine whether or not the efficiency advantage of the self-cooled unit will eventually offset the initial cost disadvantage. When the data has been accumulated, a break-even graph will point out the relative cost advantages of the two transformers.

The graph, Fig. 6, is based on the following data covering 75,000-kw transformers when using an 85-percent load factor:

Fixed Expense:

	Self-cooled	Forced-oil
Initial transformer cost	$ 226,000	$ 149,500
Cost of additional generating capacity to supply losses @ $300 per kw	85,500	121,350
Total fixed expense	$ 311,500	$ 270,850
Variable Expense (Annual):		
Transformer loss	285 kw	404.5 kw
Cost of energy to supply transformer losses @ 3 mills per kw-hr	$ 7,460	$ 10,600
Interest on investment at 3%	9,345	8,126
Total annual expenses	$ 16,805	$ 18,726

Using this data, Fig. 6 shows that after approximately 21 years the self-cooled transformer's effi-

ciency will overcome the cost differential. Now assume that generator capacity is already on hand for supplying the losses in the new transformers:

	Self-cooled	Forced-oil
Fixed Expense:		
Initial cost	$ 226,000	$ 149,500
Variable Expense:		
Cost of energy to supply transformer losses @ 3 mills per kw-hr	7,460	10,600
Interest @ 3%	6,780	4,485
Total variable expense	$ 14,240	$ 15,085

Fig. 7 was prepared using this data and shows that approximately 90 years are required before the relative costs are equal.

Another change in our assumed data supposes that the cost of energy to supply losses is raised to 5 mills per kw-hr. '

	Self-cooled	Forced-oil
Fixed Expense:		
Initial cost	$ 226,000	$ 149,500
Variable Expense:		
Cost of energy to supply transformer losses @ 5 mills per kw-hr	12,450	17,700
Interest @ 3%	6,780	4,485
Total variable expense	$ 19,230	$ 22,185

The break-even point now appears at approximately 26 years in Fig. 8.

These last three graphs show the importance of giving careful consideration to all the cost components. Significant cost factors must be accurately weighed to insure an accurate answer. However, a break-even graph can easily be made over-complicated if too many minor cost factors are brought into consideration; a minor factor is one which will have little bearing on the final location of the break-even point.

Analyze Data

To avoid misrepresentation, the consulting engineer should carefully analyze all the pertinent facts. He should weed out or combine the minor ones and list those of significant importance. Some of the factors which should be weighed include interest on the investment, obsolescence, effect on maintenance expenses, and effect on pay scales. The nature of the individual problem will determine the handling of these factors. Obsolescense, for example, is important in some industries and will restrict the desired amortization point in spite of the anticipated useful life of the machine.

With care taken to make an honest presentation, the break-even graph is a valuable tool for presenting facts to the technically trained as well as to those with limited technical background.

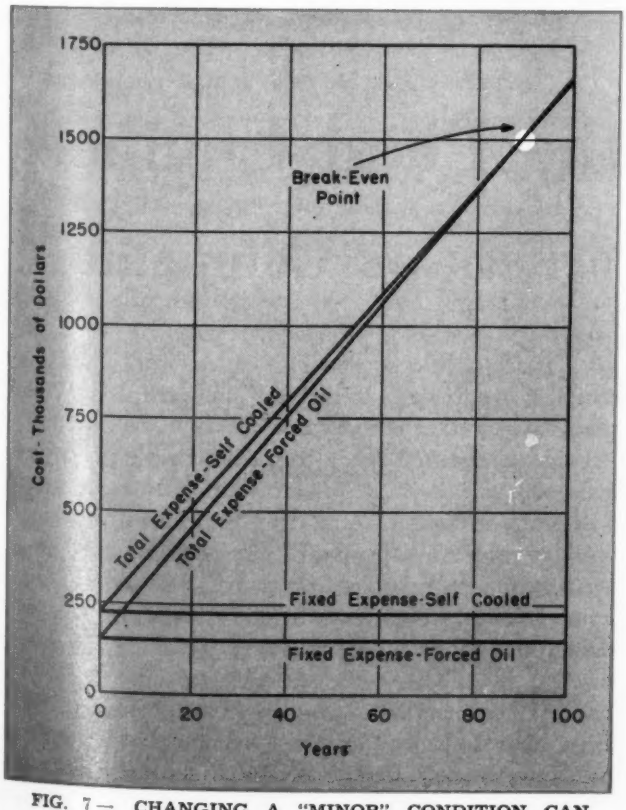


FIG. 7 — CHANGING A "MINOR" CONDITION CAN MOVE BREAK-EVEN POINT 69 YEARS FROM FIG. 6.

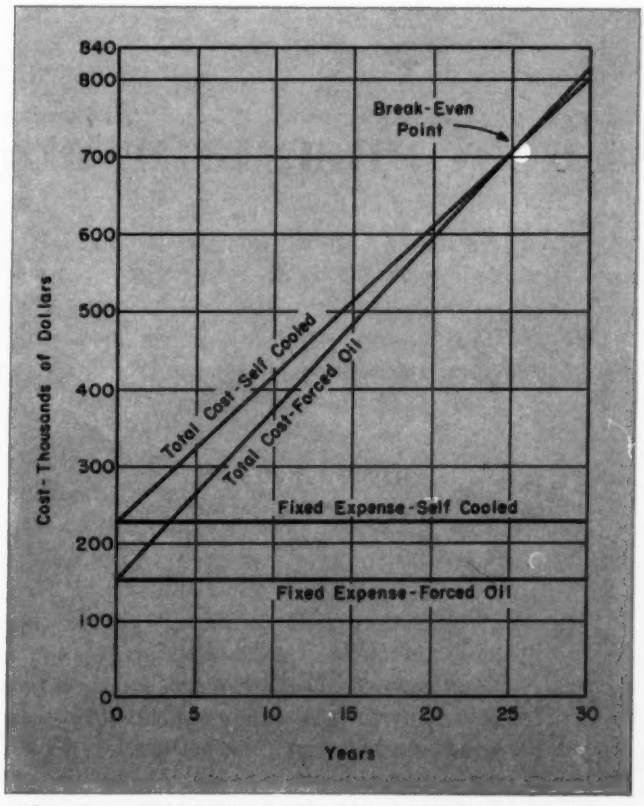


FIG. 8 — CHANGING RATE FOR LOSSES BY 66 PERCENT MOVES BREAK-EVEN POINT 5 YEARS FROM FIG. 6.

WHEN TIME IS IMPORTANT, CONSULTING ENGINEERS HAVE THE ADVANTAGE SINCE THEY CAN CONCENTRATE ON A PROJECT WITHOUT THE INTERRUPTIONS OF THE DAY-BY-DAY EMERGENCIES THAT PLAGUE PLANT ENGINEERS.

The Consultant and the Plant Engineer

. . . Co-workers or Competitors?

CE exclusive

JOHN C. HITT
Jackson and Moreland

LET'S SUPPOSE that your firm is a sizeable consulting engineering organization with experience in various power fields. It has worked on a few industrial jobs, but they have been mostly large, rather isolated projects such as industrial power plants. More industrial work would be advantageous, and you are wondering if it would not be possible to handle a good many of the problems with which a progressive industrial plant is faced. What, then, are your chances?

Perhaps the first thing to understand is who your competition will be. The most obvious competition will be from other consulting engineers. Although your organization probably competes against other consultants on most of the work it is now doing, when it enters competition for industrial work you may, for the first time, find strong rivalry from much smaller firms.

Your real rival, however, will be the plant engineer. This does not necessarily mean that he will be hostile—he may even ask for the help that your firm can provide. It is nevertheless axiomatic that the management of an industry is not going to sup-

port a plant engineering department and, in addition, pay the relatively high cost of having work done by a consulting engineer, unless it is persuaded of some advantages in doing so.

Plant Engineers

When a company first starts out on a modest scale, the plant engineer, if there is a man with that title, is usually a practical man who knows how to keep the production equipment running and is likely to be more of a mechanic than an engineer in the professional sense. As the company grows, however, it has to spend money on transformers, switchgear, and air compressors, and it begins to use such equipment as resistance welders, induction heaters, heat-treating furnaces, electroplating equipment, and complex automatic controls. Also there begin to be problems of noise control, special lighting, ventilation, and unusual foundations. By now, the company requires a plant engineering department headed by a fully competent engineer and staffed by a group of versatile engineers and draftsmen.

In a large company with rapidly changing equipment and process requirements (such as in the aircraft and automotive industries) the plant engineering department may number several hundred men. So the "plant engineer" whom you are proposing to supplement on a particular project may vary all the way from a handy-man with a title to an organization that's bigger than most consulting engineering firms.

With this in mind, let's consider how the work that a consulting engineer can do for a company will differ from what the company's own plant engineering department can do on the same project.

Quality of Work

A consulting engineer can usually do a better job of fundamental engineering than a plant engineering department because, in addition to having a first-class crew of men, he is more in the swim of new technical information, he has experience in more fields, and he is further from the details of the problem. Thus, the consultant tends to take a more fundamental approach.

Also, consulting engineers have more at stake. A plant engineer won't be fired for one faulty recommendation, and he has constantly recurring chances to redeem himself. If he designs something and it doesn't work, he's right there to modify it until it does. On the other hand, the consultant is on a spot. One mistake and he may lose a client and—more important—damage his reputation elsewhere. The consultant's engineering has to be good every time.

When management hires a consulting engineer to do a job, the consultant has one advantage that the plant engineer probably envies. He can sell ideas to the management that the plant engineer could never get across. The consulting engineer is the "expert" (until he proves himself otherwise), and what he says receives serious consideration—if for no other reason than because the management has paid good money to hear it. This puts the consultant in a strong position to introduce really new ideas to his client.

Greater Detail

For a design project, the consulting engineer prepares the drawings in his own office, and the construction work will be done by the plant's own forces or a separate contractor (assuming that he is a consulting engineer—not a construction contractor with a design staff). This means that the drawings must be prepared in considerable detail, with careful attention to design features. Thus, the client receives a good set of drawings for his permanent files, as compared to the drawings made by plant engineering departments which frequently are too sketchy to be of much use in later years. Also, the drawings are sufficiently complete to allow a contractor to submit a fixed-price quotation which includes only a minimum allowance for unforeseen difficulties.

A consulting engineer has another advantage in that he should be able to design a project more quickly than the plant engineer, since his men can concentrate on the project without the interruptions of the day-by-day emergencies that plague a plant engineering department. This emphasis on speed implies that only a moderate amount of liaison is required, and that decisions are obtained promptly from the client. If these conditions are not met, either the consultant has been given a job that belongs in the plant engineering department, or the management is wasting part of the money it is paying to the consultant.

Cost Comparison

The one comparison between the consulting engineer and the plant engineer that may loom most importantly to the industry's management is that the services of a consultant may cost a great deal of money. There are several reasons why the consultant's costs are higher than those of the plant engineer, but there also are numerous reasons why they may only seem higher.

Often the consultant does a more thorough and detailed job—and quality costs money. His men, quite likely, are higher paid, and there is always some time and expense for travel between the consultant's office and the client's plant. The consultant's bill must include all of these direct costs, as well as all of his overhead.

In comparing consultant's fees with the cost of having the work done by the plant engineering department, management may overlook such items of the latter's direct and overhead costs as vacations,

—Continued on page 86

Linear Programming

...For Optimum Production

ALEXANDER HENDERSON
Carnegie Institute of Technology

CE exclusive

Table I			
Machines	Time On Machines		Available Machine Time
	I	II	
A	1 hr	.5 hr	1000 hrs
B	1	3	2100
Price of Products	$1	$1	

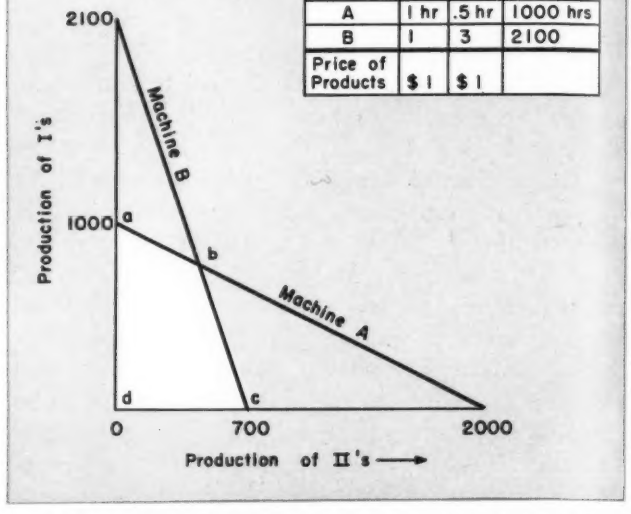


FIG. 1 — THIS SIMPLE GRAPH INVOLVES MAKING TWO ITEMS, EACH GOING THROUGH TWO MACHINES.

LINEAR PROGRAMMING is a relatively new technique which is enabling management to solve problems which formerly have been baffling. The general approach is to calculate the best achievable result subject to existing limitations.

This is comparatively simple as long as the limitations are exact; the problem is much more complex when they are not. Thus, the limitation may be that there are 1000 hours available on a particular machine; not more than this amount can be used, but nothing forces the firm to use all the available time. Or, the sales department may require the production of 200 units of a product, but any excess can be usefully put into stock. In the first case, the limitation is "not more than 1000 hours"; in the second case it is "at least 200 units." There may be other limitations, too. The product may be made to order and be useless in stock; then the limitation is that "exactly 200 units" must be produced.

Best Solution

Once the limitations have been determined, the "best" solution is sought which conforms to these limitations. The purpose of any linear programming system is to achieve the plan which is best from management's point of view.

A linear programming system can only deal with objectives which are proportional to the output or with limitations which are proportional to the strain put on them. These conditions are met in a wide range of business problems but not in all. The objective may be to produce as much as possible in excess of minimum requirements; if 200 excess is twice as good as 100 excess, then the conditions are met. It is also possible to program the system if each unit put into store is valued at $2 up to a limit of 100 units and then is worth only $1 for additional units. But it is not possible to deal with non-linear problems such as making the cube root of the excess as large as possible.

Conditions of Linearity

The condition of linearity also must be met by the limitations on the program. Thus, the purchase of 10 tons of material should cost twice as much as 5 tons. This is often a fair approximation, but there easily may be exceptions. There may be discounts on large quantities; these can usually be dealt with by saying that the cost per unit is so much for quantities up to a specified limit and then is smaller for larger quantities. There may be several such steps. For machines, there is the complication of set-up times; these can only be dealt with by using some trick in calculating.

Two specific cases illustrate the nature of the problems which have actually been dealt with successfully. In refining petroleum, the end products can be varied within wide limits according to the demand for various grades of gasoline and by-products. The problem is to schedule the work of the refinery to obtain the largest total receipts for the petroleum which is processed. Another case is the distillation of tar; distillates are combined with each other and with products bought outside. The problem is to meet certain quality conditions, to supply certain minimum amounts of some products, and not to exceed the capacity of any process stage.

The nature of linear programming can best be il-

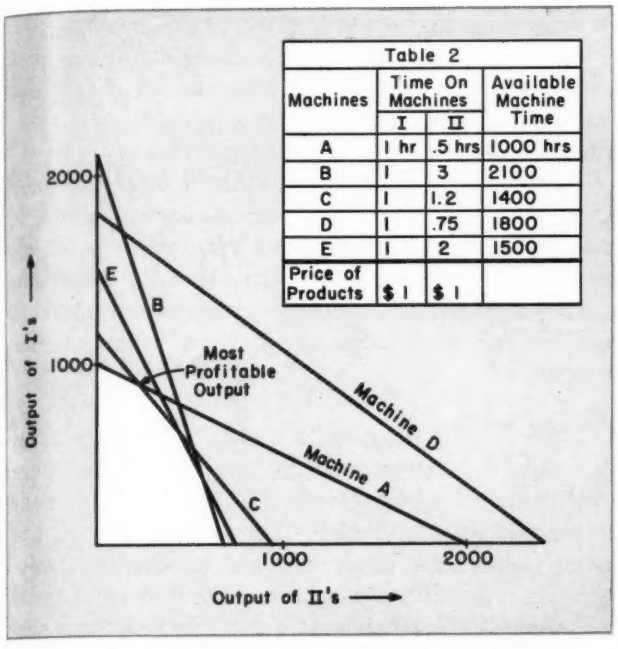


FIG. 2 — PROBLEM OF FIG. 1 GETS COMPLICATED IF ITEMS MUST GO THROUGH FIVE MACHINES.

lustrated by taking a simple problem and then complicating it. Let the problem be that of deciding the quantities of two products which shall be produced on the available equipment. Table 1 sets out the limitations. Both products have to pass through both machines, but the machine times are different. The last column gives the available machine time after allowing for maintenance and set-up. The last row gives the net prices after deducting the value of the material that goes into the product.

This problem is very easily solved graphically. Fig. 1 shows the two sets of limitations. Line A shows the output obtainable if machine A were the only limitation. This shows that 1000 units of I or 2000 units of II could be produced with this machine; a combination—such as 800 units of I and 400 units of II—could be produced. Of course, any smaller amount can be made. Hence the line A indicates that as far as machine A is concerned, only those combinations of outputs below that line can be produced; conditions are similar with line B. Hence the only possible outputs are those below both line A and line B. This is the area a, b, c, d.

Profitable Output

Then the problem is to find the most profitable output subject to these limitations. It must be one of the extreme points a, b, c, or d. In this case it is point b, representing an output of 780 units of I's and of 440 units of II's. At $1 per unit, this production brings in $1220; no other point,—a, c, or d—brings in as much. If the prices were different, point a or point c might be the most profitable.

Now complicate the matter a little by having five machines instead of two. The data are shown in Table 2 and the resulting achievable outputs are shown in Fig. 2. The most profitable output is shown; it is when 800 of I and 200 of II are produced. At this output, the full capacity of machines A and C will be used, whereas some capacity of the other three machines will be idle.

New Limitations

Still a further complication can be introduced. Suppose that for both products there is a minimum output which must be maintained and that there is also a maximum output which the firm thinks it can sell. The new set of possible outputs is shown in Fig. 3. This is an enlargement of Fig. 2, with the area delimited by the points a, b, c, d, e, f. If both products sell for $1, the most profitable point is point b. Now we have superimposed the marketing limitation which excludes point b. This leaves the indicated point as the most profitable output.

Further complications can be introduced; for example, some of product I might be incorporated into product II. Instead of there being a maximum output, it might be that outputs above a certain limit could only be sold at a discount.

Now all these complications can be dealt with graphically. But what happens if the number of products is increased? Then using diagrams is no longer possible and it becomes necessary to use straight mathematics.

Programming Drafting

Calculated potential output frequently proves to be impossible. One case involved the use of draftsmen's time; a really hard-pressed department showed up as capable of dealing with ten times the present load and then having some spare time. In the actual case, the load had been underestimated; so had the time actually required for the drafting. The next step was to return to the plant and discover the realistic limitations under which the firm was actually working. When these were found and checked against actual performance, they were found to be so shocking and surprising that the urgent job was to alter them.

The next task was to find out what the firm wanted to achieve. (In few cases does this emerge immediately.) In his non-formalized scheduling of the drafting department, the chief draftsman had used his intuition. Any formalized apparatus which might be substituted for this intuition would have only the sense that he would put into it.

Balancing Staff

The first consideration is that one program is better than another if it sets more men free for other tasks, or enables the staff to be reduced. Even this may be inappropriate; the firm may need to keep its trained personnel together and may not have any other immediate tasks to employ them on. The firm

then has to make a decision as to the importance it places on economizing draftsmen's labor whenever that is short.

Costly Overburdening

Then the question arises as to what is to happen when the demands on a department exceed its capacity. In practice, what usually happens is that the work is skimped. A little hurrying of the work, so that it takes less than the desirable time, may not do any harm. But as soon as the work is rushed through at abnormal rates, the output begins to suffer and working with the designs ultimately becomes more expensive. Hence there is a definite cost in overburdening the departments. Someone must be willing to give a value to this cost over various ranges.

It is apparent that no one can make a good estimate of these costs without detailed knowledge of the firm's workings; indeed those in the firm will usually refuse to do so. If the executives do refuse to estimate a cost, the consultant will propose a plausible number. This will rouse objections and changes can be made until a value is found where the executives are equally balanced in attacking it as too low or as too high. Then it is possible to proceed.

Farm Work Out

It may be that the solution to an excessive burden on one department will be to farm work out to other companies or to transfer men between departments. If so, these adjustments must be included and the costs estimated again. It is apparent that except in very simple cases, the problem of deciding what the firm wants to do is difficult and no really complete solution is attainable.

In this way, the major objectives of the firm are formulated with respect to the problem. There will be minor objectives, too. Alternative ways of producing the same designs exist. Usually there will be some preferences between different methods, though the preferences may not be sufficiently strong to justify putting a price on the gain from using one method rather than another. Or there may be a preference against overworking one department when another is seriously underworked. If the matter is important enough, it can be made into a major objective and incorporated in the programming model —provided management is willing to put a price on the preference. But when this is not done, the mechanization does not prevent subsequent adjustment of the program to take these secondary aims into account later.

Compare Past Periods

It is usually helpful to calculate the program for some past period, and then to compare that program with the plan that was actually made. There are usually substantial differences. Often these differences result from additional objectives which had not originally been listed; some production factors which were not mentioned earlier turn out to have influenced the actual choices. When recalculated, the usual experience is that the results fairly well correlate.

It often turns out, however, that the programmer has deformed the problem somewhat to make it easier for him to solve. In deforming the problem, the advantage in calculation may be only a fraction of a percent. But the calculation can tackle the real problem and then it may well show much greater advantages.

Eliminate Intuition

Calculations force business to give figures where it had been acting on intuition. This is one of the advantages of mechanization. It forces management to decide just what it does want and to set out this decision in a form in which it can be understood and criticized. It then becomes clear what is profitable and what is not. A single policy can be used throughout the firm.

However, this is strongly against our habits of mind. We prefer not to value things but to merely make decisions. But when the choices involved are so complicated that one cannot keep all the alternatives in mind simultaneously, then the case for putting a figure to the benefit or cost become very strong.

Linear programming systems allow some compromise. We must give a figure to the major elements in the problem, but we may reserve certain other elements as a basis for modification. In one case, there were 15 possible methods. Putting a value on idle time and on rushed work led to a solution which qualified but seven of these methods.

When management has become sufficiently confident in the flexibility of linear programming and their ability to understand the figures it produces, it can be used for actual cases. Often, the system of interrelations turns out to be so very complex that machine calculation is required. However, once the general form has been fixed, short-cut methods can often be found which produce the results quickly and without the aid of calculating equipment.

Other Operations Affected

Normally, the original problem is only a part of the complex operation of a business. Now the formal planning of one part of the system can affect others. In planning shipments to retail outlets, the problem is simply to keep the freight bill down while distributing the available supply to the retailers. Then the problem arises as to the location of new factories. Additional output is required and can be placed at any of the existing or new manufacturing centers. Thus what started as a problem confined to distribution is now affecting the production department.

To take another example, the initial problem may

be that of scheduling machine times for a number of products. Then the investment problem arises. New machines must be purchased and it is necessary to decide what types of machines are most worth purchasing. Once again, the calculation of production schedules by linear programming has produced a valuation on an hour's use of each type of machine. The original linear programming system comes to extend into other aspects of the firm's operations which it was not originally intended to help.

Ultimate Extension

The ultimate extension, which we are far from reaching yet, is a fully automatized system. A fully automatized system of business decisions means that there is a body of men who decide what the firm wants to do and what the future will be like. They make decisions by choosing numbers; no machine makes these choices for them. Once all the numbers have been chosen, the calculating machine works out the implications and issues the orders for purchase and production. Checks must be maintained to see that the mathematical model still represents what is happening in the plant. The role of top management remains substantially unaltered as does that of the accounting department. The curtailment is in the decision-making at intermediate levels—the transport manager or the production scheduler. Their decisions can largely be made by advance calculation. However, the knowledge that these people amass is still needed, though it can often be supplemented by more manageable records of production.

Consultants' Problems

If any consulting engineer has some problem within his own organization that looks like a linear programming problem, how should he go about applying the technique? There are three main ways to proceed. Find someone inside the firm who has done some mathematics and set him down for a week or so to study the method. Quite moderate mathematical competence will do; the study of easily available material should enable him to understand the method. Then the inside expert can attempt to explore the methods of application and report his results when he has mastered the methods.

This method has worked successfully in many cases. It is relatively difficult, however. The inside expert is usually a bright young man with but humble status in the organization. Hence he will have difficulty in dealing with his superior unless approval from on high is strongly emphasized. Such difficulties do arise if there is any conservative sentiment in the company—and in what company is there none?

The second method involves making use of academic experts in the field. These may well be an economist and a mathematician working together. They will have plenty of experience and be able to meet any technical difficulty which is actually soluble with present knowledge. Their limitation is that they will not normally be prepared to study in detail the actual operation or to devote the necessary time to finding out exactly what management wants.

The contact with management must be very close, for the whole purpose of the system is to find the best way of achieving the ends of management. Since these ends have often not been stated explicitly beforehand, this takes time and trouble.

The third method is to use academic experts together with a firm of ordinary management consultants. Then the consultants can obtain the necessary factual information under general guidance from the experts. At the same time they can make suggestions for the improvement of current practices. In many circumstances this has proved the most satisfactory method of application.

A final warning—there are many problems for which linear programming can give little help. These include most of the problems relating to forecasting. In other problems which fit into the scheme perfectly, the only apparent result may be to confirm that less formalized methods of programming have been very successful. In these cases, there are usually some indirect benefits which will justify the expense in installing the system, but the gain may be quite small. In other cases, programming may be unsuccessful because of the difficulty in deciding what the firm really wants to do.

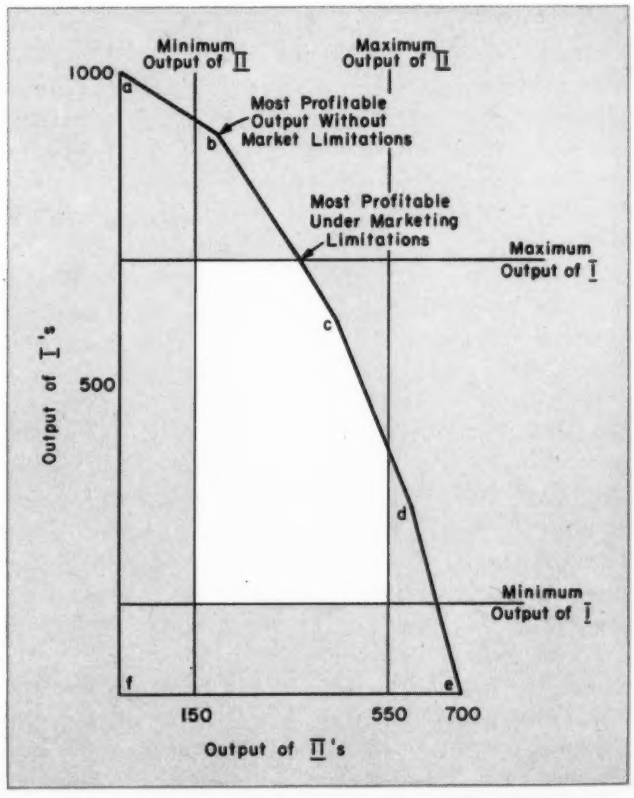


FIG. 3—PROBLEM OF FIG. 2 CAN BE FURTHER COMPLICATED BY ADDING MAXIMUMS AND MINIMUMS.

CE exclusive

Reduce Filing Space by

Storing Your Drawings On Microfilm

E. T. FREEL
Microfilm Division
Remington Rand Inc.

MOST BUSINESS records are of such a nature that destruction is possible after suitable or legally required intervals have elapsed, thereby clearing out files periodically. The average engineering drawing, however, must be preserved indefinitely. The reasons for keeping drawings intact are well known. A bridge may stand for a century, or a ship may ply the trade lanes for sixty years—then, a girder shows excessive deflection or the keel warps, causing the vessel to steam in circles. Only quick access to the correct set of prints will enable the consultant to draw up an emergency design for remedial bracing, or to rush specifications to a far-off port.

Most engineering firms have struggled with the problem of devising a suitable means of filing their accumulation of drawings. Consequently, a fantastic variety of identification systems, cross-references, and storage facilities have been concocted to provide safe storage and practical reference. This problem became acute in the field of business paperwork sometime ago. By 1928, microfilming of documents had been perfected, particularly for use in banks. It is now a basic tool of business, and the danger of war has entrenched it even more firmly as a means of safeguarding documents without which our economy could not function.

More recently, facilities and techniques have been developed for microfilming of engineering drawings. Reliable and inexpensive methods are presently available to engineering firms.

Among the many advantages of microfilming, the most important is that of saving space. Microfilm reduces the floor space requirements for storage as much as 98 percent, and it can save filing unit costs at a ratio of 225 to 1.

Safety is another important consideration. Modern safety-film has a life expectancy at least as long as the best rag bond, it is slow-burning, and it is nonselfcombustible. Microfilm copies, duplicating active paper filing systems, can be stored in remote locations or in vaults at negligible cost.

Modern scanning methods also make it practical to use positive films as the primary reference source, with the negatives held in safe storage. With methods such as Remington Rand's Microdex and Filmsort, microfilmed drawings can be referred to easier and faster than the best available physical filing system for originals or prints.

Equipment

Engineering drawings are commonly recorded on 35mm film, although smaller drawing sizes can be filmed on 16mm rolls using a high-speed, automatically fed camera of the type used for business records. The portable planetary cameras used for 35-mm work will handle drawings up to 24 x 36 inches, and continuous strip drawings up to 36 inches wide

and indefinitely long. These limitations are determined by the practical size for portable equipment (permanently installed cameras are used to handle larger originals), and by the film grain and lens resolving power, which limit the reduction ratio to 30 diameters. Whenever feasible, reduction ratios are held below 21 diameters to guarantee reproduction of the finest detail.

Microfilm, whether spooled or cut into individual frames, is read on viewers or readers which are available in many types and sizes. They all operate by projecting an enlarged image on a ground glass screen, the degree of enlargement depending upon the lens and the physical dimensions of the viewer. Spooled film is generally scanned on motor-driven viewers, while individual frame mountings are placed in a carrier.

The type of viewer recommended for engineering drawings is a floor model, about the size of a small office desk. It reproduces a 24 x 36 inch drawing full-size, and it allows several people to inspect a drawing simultaneously. It also can be used efficiently in normal room lighting. A typical unit of this type, Filmsort's Surveyor, is equipped with a lever-actuated lens changeover to provide several ratios of film enlargement, and with auxiliary motor-driven spindles for roll film scanning.

Reproductions can be produced with a photographic enlarger, which provides the most perfect copy, or by contact printing the new slow-emulsion sensitized papers by means of the viewer. The viewer can be used as a printer under normal office lighting conditions, and it provides satisfactory prints without a darkroom or specially trained operating personnel.

Indexing

The actual mechanics of indexing for reference searching will depend upon the film mounting chosen and upon the specific needs of the firm. There are three basic methods of reference. Spooling the film in 100-ft lengths and boxing the reels with drawing numbers or descriptions of the contents is principally used for documents although smaller sizes of drawings also can be handled economically and efficiently by this means. One indexing method, developed for rapid searching of spooled film, uses pre-printed spots on the film to determine the contents by numerical divisions or by related groups of items.

The other two systems involve mounting individual frames, either singly or in related groups, on cards designed for filing under any of a number of standard indexing systems, or for sorting by punched-card equipment. These methods allow direct reference to the desired card, thus avoiding the need for scanning unwanted material.

The cards used with the Filmsort method have diecut windows into which the individual frames of film are mounted. Since this does not add thickness to the card itself, it is feasible to use punched-cards and to sort them repeatedly without damage to the film. Properly devised numbering or coding systems will thus enable a related series of prints and revisions to be extracted swiftly from a master file, without the danger of accidentally omitting one of the series.

Microfilming Services

Although some firms purchase complete microfilm equipment, even to the extent of buying automatic film processing machines, by far the most popular arrangement is rental of a complete service. The usual procedure is to rent the viewers and to contract for organizing the drawings for the initial transfer of the existing file to film and for periodic filming of new material to keep the main film file up-to-date.

This service undertakes to set up proper sequences of drawings, and to film them in such a way that the customer's engineers can refer to them at any time during the operation. To eliminate the necessity of removing originals from the engineer's offices, a suitable camera, or more than one if needed, can be moved into the customer's office.

The extent to which the consulting engineer's own personnel are trained to assume various phases of the microfilming operation and routine varies. Some use only the initial filming service with their own personnel carrying on from there, while others

—Continued on page 82

FLOOR MODEL VIEWERS PROVIDE FULL-SCALE REPRODUCTIONS OF DRAWINGS AS LARGE AS 24 x 36 INCHES.

TABLE 1

COMMERCIALLY AVAILABLE FORMS OF TITANIUM*

Designation**	Sheet	Strip	Plate	Wire	Bars	Forging bar	Forgings	Tubing
Commercial Titanium	X	X	X	X	X	X	X	X
Rc-130A	X							
Rc-130B					X	X	X	
Ti-100A	X	X	X	X	X	X	X	
Ti-140A	X	X	X	X	X	X	X	
Ti-150A			X	X	X	X	X	
Ti-155AX***					X	X	X	
Rs-110	X			X	X	X	X	
Rs-120	X			X	X	X	X	
MST 3A1 5Cr					X	X	X	
MST 2-5Fe-2-5V	X	X			X	X	X	
MST 2A1-2Fe	X	X			X	X	X	

*In many instances, direct contact with mill may develop situatoins in which forms not generally available may be acquired by special order.
**Rc — Rem Cru Titanium; Ti — Titanium Metals; Rs — Republic Steel; MST — Mallory Sharon.
***Experimental Grade.

The Coming Role of Titanium

CE exclusive

R. W. HANZEL
Metallurgical Engineer
Sunbeam Corporation

TITANIUM, the world's fourth most abundant structural metal, is coming of age. Current programs to expand basic titanium production, under the sponsorship of the Defense Materials Procurement Agency, represent an estimated expenditure in excess of $100 million. Such a program is anticipated to increase current production 10 times by 1956 or 1957. British production is expected to increase also, as is the production of a recent newcomer in the titanium race—Japan.

The base price of titanium and its commercial alloys today ranges between $5 per pound and $15 per pound, depending upon the composition and the form.

While titanium ore is abundant and the mining of large ore deposits is relatively inexpensive, costs of reducing the ore to the metallic stage are high. Most producers are using the Kroll process or modifications of it. The Kroll process is a batch-type operation, and consequently production is slow. Processing materials are expensive (high-purity magnesium, chlorine, and other chemicals). No economic method has yet been devised to recover these materials for reuse. Furthermore, lots do not run consistently in batch-type operations as a result of the pickup of residual contaminants. Only small lots of quality-controlled scrap can be safely used in furnace charges.

Major difficulties are associated with handling the molten metal itself. Molten titanium absorbs gases rapidly and reacts with practically every known refractory material. This is exceedingly important because small traces of impurities drastically alter the properties of the metal. These two important problems have been solved, though not economically, by melting in an inert atmosphere and by using water-cooled metal crucibles. This type of operation tends to limit the size of ingot that can be economically produced; however, ingot sizes approaching 2000 pounds have been poured. This type of melting naturally adds to the cost of the over-all process; most important, it presents a problem in producing a consistently high quality metal in production quantities on a regular schedule.

Some companies have sought to reduce production costs through the development of an electrolytic extraction process. It was anticipated that costs could be cut from present base price to about $1.00 per pound or less for the intermediate sponge metal. As of this date, however, such processes are probably still in the research stage and are not expected to make significant cost reductions very soon.

Still another important factor affecting titanium's future lies in reducing costs of converting the ingot into finished mill products. The 200- to 300-percent price differential between sponge metal and finished mill products is primarily due to limited ingot size (as compared to steel), poor yields in mill operation,

and the inability to economically utilize titanium scrap. As titanium technology is broadened, however, it will become easier to fabricate, yields should increase, scrap loss will be reduced, and the cost of titanium metal should drop.

There are at present three basic commercial classifications of titanium metal. They are iodide titanium, commercially pure titanium, and the alloyed titanium forms.

Iodide titanium is the highest purity form of the material produced. The purification process is expensive and generally a small batch-type operation. The resultant metal has the following average physical properties: ultimate strength—35,000 psi, yield strength—15,000 psi, elongation—55 percent, and area reduction—80 percent. The iodide titanium is weak and ductile and at the present time holds no commercial promise. It is used primarily by research organizations for alloy development work.

Commercially pure titanium is the highest purity metal produced in commercial, large-scale production. This metal, by strict metallurgical interpretation, is an alloy of titanium and the residual elements oxygen, nitrogen, carbon, and iron. The titanium content of this material, however, generally exceeds 99 percent. Commercially pure titanium does not respond to heat treatment, but it can be cold worked. The material is produced in plate, sheet, strip, bars, forgings, and tubing. It cannot, at present, be cast by conventional methods because of the extreme reactivity of the molten metal with gases and mold materials.

Numerous alloy combinations have been investigated in the laboratory; however, few have widespread commercial significance. The presently available commercial alloys in production at major producers contain various combinations of iron, chromium, aluminum, molybdenum, manganese, and vanadium. These alloying elements, with the exception of aluminum, stabilize the high-temperature phase and produce alloys which are hardened by heat treatment. Aluminum and the metalloid elements tend to stabilize the low-temperature phase.

Titanium can be classed as a middle-weight since it is approximately 50 percent heavier than aluminum and 50 percent lighter than alloy steel. Its alloys are exceptionally strong while retaining ductility. Alloys are available with tensile strengths approaching 200,000 psi with an elongation of 8 to 10 percent. Titanium's strength-weight ratio is far superior to the majority of the usual engineering metals, and its endurance limit consistently exceeds 50 percent of its tensile strength. The fatigue strength of titanium and its commercial alloys compares favorably with that of steel.

Notch-sensitivity is still somewhat doubtful as investigators report a variety of results. It appears, however, that this condition may compare favorably with that of steel.

On the other hand, titanium is not generally suited for applications involving temperatures much above 1000 F. Above this temperature, many of the desirable features of titanium metal are seriously reduced.

One of the lesser publicized characteristics is titanium's natural tendency to seize and gall. When coupled with itself or another metal, rapid self-destruction of the titanium takes place. Present-day

TABLE 2

NOMINAL PHYSICAL PROPERTIES OF TITANIUM MATERIALS

Material	Density lb/cu in	Thermal Conductivity Btu/hr/sq ft/ ft/deg F	Coefficient of Expansion per deg F	Specific Heat Btu/lb/deg F	Electrical Resistivity Micro-ohm cm	Modulus of Elasticity psi x 10^6
Commercial Titanium	0.162	8 to 10	5.0×10^{-6}	0.13	50-60	15.0 to 16.0
Rc-130A	0.17					15.5
Rc-130B	0.17					15.5
Ti-100A	0.164				58	
Ti-140A	0.168		4.9×10^{-6}		79	
Ti-150A	0.168	8 to 10	to	0.13	60	16.0
Ti-155AX	0.163		5.1×10^{-6}			
RS-110						
RS-120						
MST 3Al 5Cr	0.166		5.0×10^{-6}		145-150	17.5 to 18
MST 2.5 Fe 2.5 V	0.167		5.1×10^{-6}		80-85	15.5 to 17
MST 2Al 2Fe	0.165		5.4×10^{-6}		120-125	15.5 to 17

TABLE 3
NOMINAL MECHANICAL PROPERTIES OF TITANIUM MATERIALS

Material and Form	Tensile Strength psi	Yield Strength psi	Elongation percent	Area Reduction percent
		Commercially Pure		
Rc-55				
Forgings, bar[2]	75-80,000	60-65,000	15 to 25	30 to 55
Plate, Sheet[1]				
Rc-70				
Forgings[2]	80,000	72,000	25	55
Sheet[1]	90,000	80,000	20	50
Ti-55A	55-75,000			
Ti-75A				
Sheet and strip[1]	80,000 (min)	70,000 (min)	20 (min)	
Plate[1]	70-100,000	55-80,000	18 (min)	
Wire[1-3]	75-90,000	65-80,000	20 (min)	45 to 50
	140-150,000	120-130,000	8 (min)	35 to 40
Forgings and Bar[2]	70-100,000	60-90,000	20 to 30	
RS-40	65,000	50,000	28	
RS-55	75,000	60,000	25	
RS-70	90,000	75,000	22	
MST Grade III				
Forgings[2]	80,000	65,000	25	55
Sheet[1]	80,000	65,000	25	
Sheet[4]	125,000	110,000	10	
MST Grade IV				
Forgings[2]	110,000	100,000	15	45
Sheet[1]	100,000	90,000	16	
Sheet[4]	135,000	120,000	5	
		Titanium Alloys		
Rc-130A				
Forgings[2] and Sheet[1]	120-130,000	110-115,000	10 to 25	35
Rc-130B				
Forgings[2] and Bar[2]	140-150,000	130-150,000	10 to 20	30 to 40
Ti-100A				
Sheet[1] and Strip[1]	100,000 (min)	90,000 (min)	15 (min)	
Plate[1]	100-120,000	85-115,000	15 to 22	
Wire[1-3]	100-115,000	80-95,000	20 (min)	45 to 50
	185-195,000	155-165,000	10 (min)	20 to 30
Forgings[2] and Bar[2]	90-120,000	70-95,000	15 to 25	
Ti-140A				
Sheet[1] and Strip[1]	130-150,000	120-135,000	12 (min)	
Plate[1]	130-150,000	120-135,000	12 (min)	
Wire		Experimental Only		
Forgings[2] and Bar[2]	130,000 (min)	120,000 (min)	12 (min)	
Ti-150A				
Plate[1]	140-165,000	120,000 (min)	12 (min)	
Forgings[3]	135-160,000	120,000 (min)	15 (min)	
Ti-155AX				
Forgings[1] and Bar[2]	155,000	140,000	12	
RS-110	120,000 (min)	110,000 (min)	12 (min)	
RS-120	130,000 (min)	120,000 (min)	10 (min)	
MST 3Al 5Cr	145-170,000	135-160,000	5 to 8	20 to 25
MST 2.5 Fe 2.5 V				
Forgings[2]	140-145,000	130-135,000	9 to 11	25 to 30
Sheet[1]	140-175,000	130-155,000	3 to 12	
MST 2Al 2Fe				
Forgings[2]	145-150,000	135-140,000	11 to 13	30 to 35
Sheet[1]	145-180,000	135-160,000	5 to 12	

1—annealed; 2—as forged; 3—cold drawn; 4—full hard

lubricants do not appear to greatly improve the compatibility of metal couples involving titanium. Titanium can be surface hardened by nitriding or carburizing, and such treatments tend to reduce these undesirable characteristics. However, the effect of treatment temperature is such that the physical properties may be adversely affected.

Other investigations have shown that anodic coatings produced by chemical or electrochemical means can be effective in reducing wear. Success in materially reducing seizing and galling will open up a new potential field for titanium in wear applications.

Plating Titanium

No satisfactory plating has been devised which provides adequate adhesion to titanium. Copper can be flash-plated on it, and this in turn can be joined to other metals by soldering. Welding of commercially pure titanium has met with some degree of success. It can be spot-welded, fusion-welded, seam welded, and so on.

The largest portion of the presently available metal is being channelled into defense programs. While the metal and its applications enjoy widespread publicity, government restrictions curtail the dissemination of performance information associated with many classified programs.

Aircraft and jet engine manufacturers are utilizing upwards of 80 percent of current production in military orders. The metal is being used by some companies for moderately high-temperature structural applications as a substitute for stainless steel and Inconel. Other companies, however, use it only experimentally because of the difficulty encountered in obtaining alloys of consistent quality.

It has been estimated that from 800 to 1000 pounds of titanium could be used in present-day jet engines regardless of price. Titanium has withstood tests in engine firewalls, shrouds, baffles, afterburners, and diaphragms. The greatest use, however, is for compressor disks and blades. In addition, it is being considered as a substitute for the aluminum skin surfaces of present aircraft, supersonic aircraft, rockets, and guided missiles. (Control surface conditions are critical in high-speed aircraft; heat due to skin friction and the impingement of airborne foreign particles severely roughen the surfaces, decreasing efficiency and maneuverability.) Other substitutions under consideration include lightweight armor and internal structural members.

Titanium in aircraft is important because of its strength; its lightness can increase over-all performance. This lightness will result in decreased fuel consumption, or more significant, an increase in operational range without an increase in weight. In the civilian picture, aircraft producers will be interested in the same applications and benefits that are advantageously employed in military aircraft. For instance, the new Douglas DC-7 has nacelles and firewalls of titanium which represent a weight saving of some 300 pounds.

Titanium is highly corrosion-resistant, particularly to chlorides and to oxidizing conditions. Dilute sulfuric and hydrochloric acids, most organic acids at room temperature, nitric acid and aqua regia, all have no effect on the metal. Concentrations over 5 percent of hydrochloric acid attack the metal. It is not resistant to hydrofluric or phosphoric acids at room temperature. Resistance to dilute alkalies is good, but it is attacked by moderately concentrated solutions. The many corrosive liquids handled by the chemical industry today create problems to which titanium is a likely answer.

Resistance to chemical attack results from the formation of natural protective oxide film which provides immunity in all oxidizing environments. This desirable characteristic is not impaired by alloying. When the metal does corrode, however, it is uniform in nature. Little evidence of pitting has been observed. Titanium normally is not subject to stress corrosion, cavitation erosion, corrosion fatigue, intergranular corrosion, or galvanic corrosion.

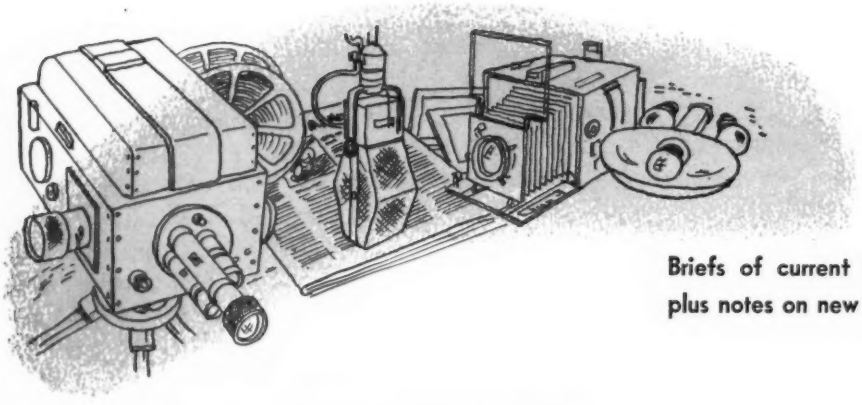
Commercial titanium is being used on a limited scale for corrosion-resistant equipment in the chemical field. Installations are being developed to handle 22-percent sulfuric acid at high pressures and temperatures and for handling concentrated ferrous chloride solutions.

Piping Systems

Titanium is passive in sea water and marine atmosphere. Its corrosion fatigue in salt water is similar to that in air. In this respect, it is exceeded only by platinum and Hasteloy C. It is one of the few known high-strength structural materials to boast this property. This naturally opens the possibilities for light-weight piping systems handling salt water, condenser tubes, water lubricated bearings, and numerous shore and ship applications. Titanium tubing is available in strengths comparable to mild or low alloy steel.

Titanium's high strength-weight ratio can advantageously be used to reduce the weight of railroad cars, truck and truck-trailer frames, busses and automobiles. Needless to say, horsepower requirements could be reduced, dead weight would be reduced, and payloads could be profitably increased.

Titanium could also be used effectively in designing portable machine tools where strength and light weight must go hand in hand. Surgical instruments and surgical plates for replacing bone are also potential uses because of the metal's desirable corrosion resistance. Water-lubricated bearings, shafts, gears, and other power transmission items are also projected uses for titanium. The field seems unlimited.



NEWS

Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering

Wet Trench Installations Possible With New Pressure Joint

A new "Pressure Joint" developed exclusively for vitrified clay pipe resembles in appearance nothing so much as a tire inner tube. Said to make possible the laying of pipe ranging in size from eight to 36 in. in diameter under all conditions, the joint utilizes a hollow rubber gasket which is placed around the spigot end of the pipe and inserted into the bell end of the adjoining length.

A grout mixture—four parts Portland cement, two to two, with 1/3 part water and one part of a special TJ-41 compound—is then pumped by hand into the joint through the attached valve. The joint expands uniformly under 50 to 60 psi pressure. After the grout sets, a tight, infiltration-proof seal forms.

One of the first jobs utilizing Pressure Joint in Eastern United States was completed recently at Cambridge, Ohio, by the G. Alfred Krebs Co. of Newark, Ohio. Shifting sand and water required heavily-braced sheeting. Hot-poured joints were practically impossible. Despite the fact that a pump was in operation full time, water seeped into the trench so fast the pipe could not be kept sufficiently dry to make a hot-poured joint. At 16 feet depth, it was possible to complete the vitrified clay pipe line utilizing only the Pressure Joint.

The grout equipment used to inflate the Pressure Joint consists of a reservoir for the grout, a hand-operated verticle pump, pressure gage, and a hose with a nozzle. The grout is pumped from the reservoir through the hose to the Pressure Joint.

A six-page brochure, which completely describes the Pressure Joint and gives detailed installation instructions, is now available from Clay Sewer Pipe Association, 311 High-Long Building, 5 East Long St., Columbus 15, Ohio. ▲▲

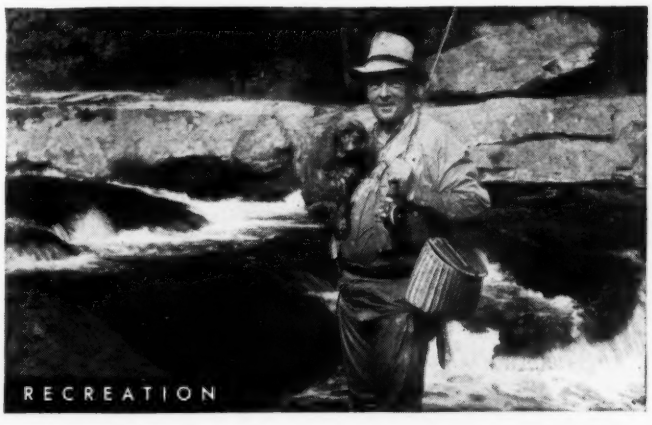
Steel Pins Are Used To Hold Insulation On Sphere

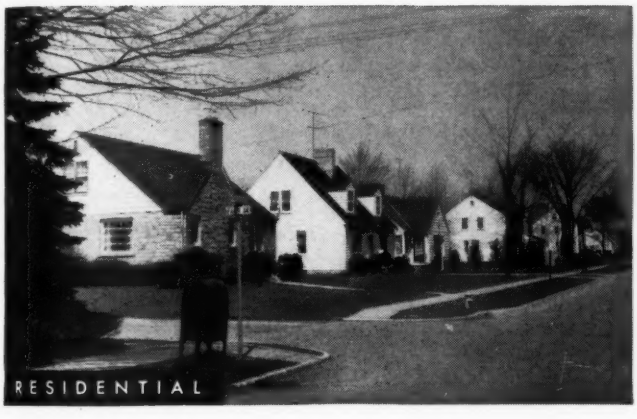
Headless insulation studs are shown being installed to hold the layer of two-inch Foamglas insulation applied over the entire surface of the Submarine Intermediate Reactor sphere in which General Electric Co. (which operates the Knolls Laboratory for AEC) will test a prototype of the nuclear powered submarine (Mark A).

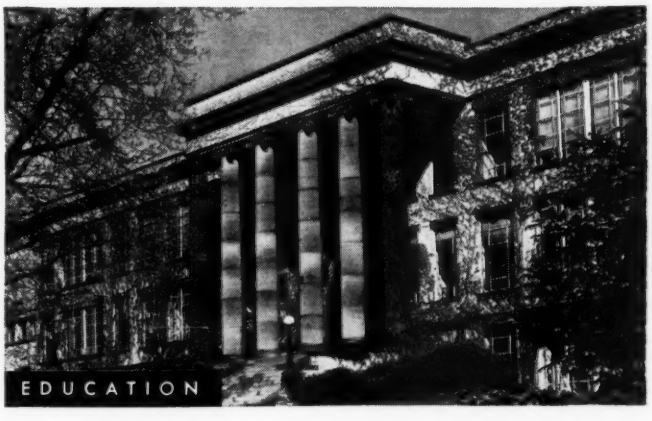
Power for the arc welding operation is provided by three Nelwelder battery units on the ground, one for every two Nelson stud welding guns.

Six welders are followed by the men who impale the Foamglas over studs on which stainless steel speed clips are installed to hold the material permanently in place. After the tips of the studs have been snipped off, the surface is then covered with

YOUR NEW PLANT WILL GROW IN THE ERIE AREA







Here's the middle-sized town—right site for your plant!

● Where are the new plants going? Figures show that the middle-sized town is getting the major share because of its opportunities for better living for all personnel.

These pictures from middle-sized towns in the Erie Area, give you some idea of their better life. Their social and recreational facilities make for better human relations—an intangible that finds its way into the company's balance sheet.

Then, of course, industry has room to grow in these middle-sized towns in the Erie Area that fit in with the Government's Dispersal Program.

The Erie Area is in the heart of the nation's largest single market. One-third of America's people live, work and buy here. Raw materials, production and markets are close together.

Industry is served by the dependable Erie Railroad which connects direct with New York Harbor for export business and offers unsurpassed service between New York and Chicago and nationwide by connecting railways.

Our experienced personnel will be glad to discuss desirable locations with you—in strict confidence, of course.

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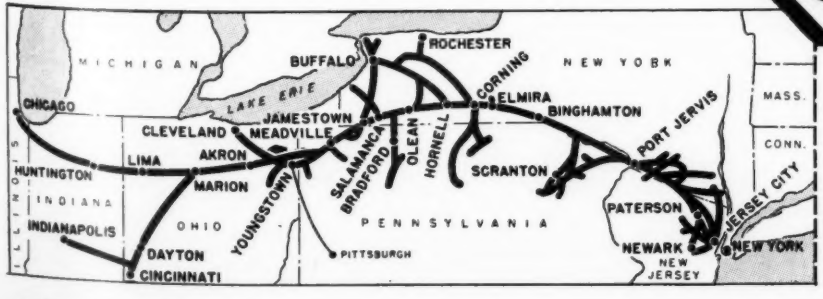
Serving the Heart of Industrial America



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D. M. Lynn, *Assistant Vice President*
Industrial Development . Rm. 524-B, Erie Railroad
Midland Building, Cleveland 15, Ohio

Dear Sir: We are interested. Please send us your Specification Card on which we can list our needs.

Name .....

Title ..... *Company* .....

Address .....

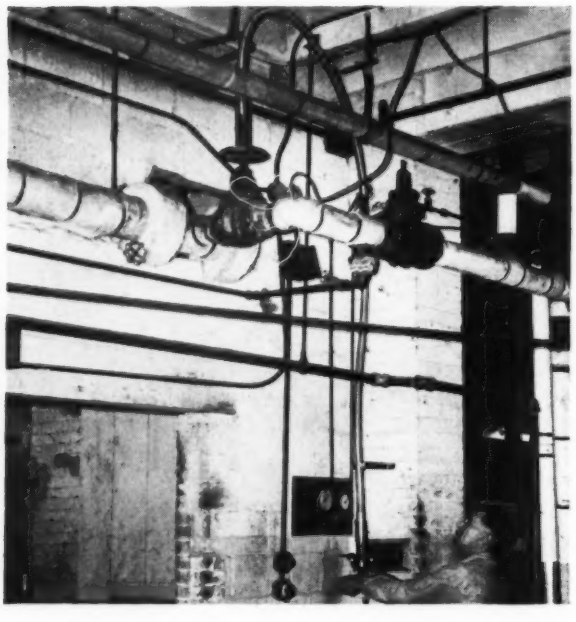
City ..... *Zone* ..... *State* .....

Steel Pins Hold Insulation

—*Starts on page 60*

glass fabric and a weather-proofing mastic coating.

Savings in time required for installation of the insulation block by this stud welding method have been estimated at something more than 50 percent by the insulation contractors, Lewis & McDowell, Inc. The sphere was built by Chicago Bridge and Iron Co. under subcontract from Rust Engineering Co., AEC's prime contractor. ▲▲



Flexible Shafting Solves Valve Control Problem

Flexible shafting, which for sometime has been used for remotely controlling valves on ships, is now being used for the same purpose in industrial plants, in boiler rooms, processing plants, and in paper manufacturing.

In the illustration, a steam valve with an eight inch handwheel is being controlled by a one inch flexible shaft with a ten inch plastic handwheel at the other end. Formerly, whenever the valve was opened or closed, the operator had to climb up a ladder.

Valves as large as those with 27 in. dia handwheels may be controlled with flexible shafting which can be as long as 50 ft.

If flexible shafting is considered when piping is to be installed, it is possible to locate the pipes and the valves in places that are inaccessible to the operator and many valves can be controlled in a plant at one time from one central station.

Design manual 528 giving complete details on the remote control of valves, may be obtained by writing Stow Manufacturing Co., 174 Shear St., Binghamton, N. Y.

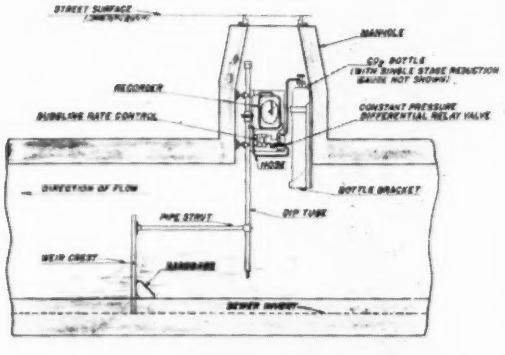
Dry Charge Batteries Available Soon

Industrial storage battery users will soon have available a new dry-charge type battery which is said to keep indefinitely for stand-by without suffering deterioration.

According to the manufacturer, Gould-National Batteries, Inc., tests indicate that the "soaking-period" or time required to bring the battery up to operating level is a fraction of that required by present batteries. Even submarine batteries, the largest built, after a long period of idleness can be brought up to charge in the time required to uncover the engines. The present type takes several days to recharge.

Another advantage will be the savings realized from the reduction or elimination of charging facilities for large installations.

The new type, over a period of time, will be made available in sizes for every application now using standard type batteries. ▲▲



LONGITUDINAL SECTION THRU SEWER

Mechanical System Developed For Measuring Sewage Flow

Developed in connection with a contract to design sewage intercepting chambers for the Philadelphia Bureau of Water, a new method of making dry weather sewage flow measurements made possible reductions in labor costs, worker health hazards, and time.

Basically, the new method substitutes a mechanical system of measuring sewage flow for the previous methods which required workers to descend to the bottom of a sewer to make readings with a current meter.

Need for the process developed while General Industries was engaged on an original contract for the design of 3 of approximately 70 new intercepting chambers required by the city. In designing the chambers it was necessary to measure the dry-weather flow of sewage. Difficulties encountered under the standard method, which utilized a current meter, were numerous. The operation had to be performed on a 24-hr basis with workers, operating in two-man teams, taking measurements with

Marietta

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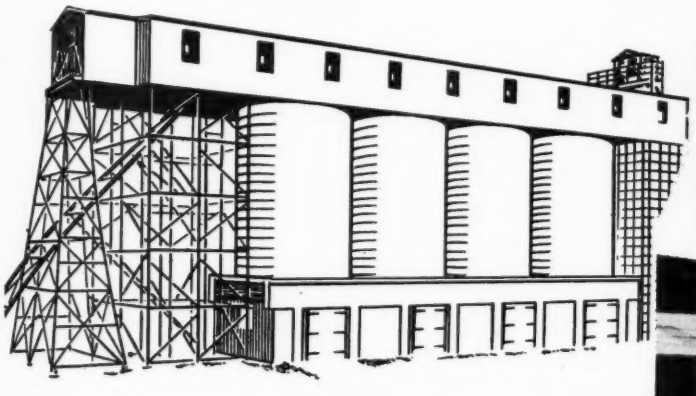
lets you think in YEARS-AHEAD terms!



From foundation to roof, a Marietta Concrete Storage System is adaptable to every type of materials-handling.

Marietta engineers, thinking in years-ahead terms, have long recognized the unpredictability of the future as an important factor permanently tied to the apron strings of industry. Constructive thinking, in the past, with particular attention to this factor, has resulted in the production of modern storage systems purposely designed for immediate conversion or expansion without imposing penalties to meet any need.

There is no limit to the equipment that can be incorporated into a Marietta silo wall, roof or floor. A flexible Marietta Silo will accommodate any discharge system.

Concrete silos erected during 1916, the year Marietta ventured into the industrial storage system business, are in useful operation today, standing as undeniable tributes to the wisdom, integrity and engineering prowess which have always been fundamental characteristics of The Marietta Concrete Corporation.

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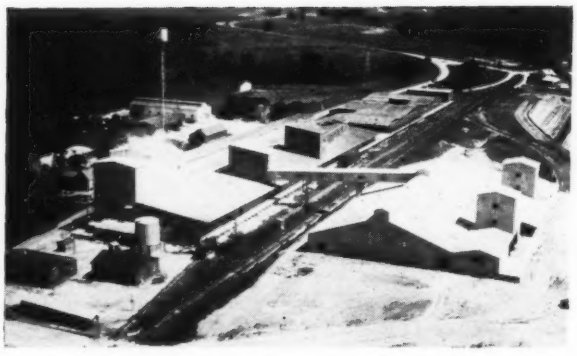
PRECAST CONCRETE PRODUCTS FOR FARM, HOME AND INDUSTRY

Sewage Flow Measured

—*Starts on page 62*

the meter every hour. Lethal gases present in the sewers were a danger, sometimes forcing the men to wear gas masks. The operation also interfered with traffic because the open manholes had to be protected by barricades. Basic components of the new measuring instrument are a tank of CO_2 gas, a metal dip tube, and a recorder or meter box—all of which can be transported and installed by two men. Fisher & Porter Co. designed a special meter which is used in connection with a dam. The dam, developed by General Industries and the contractor, Somers Construction Co., impounded enough water to make the measurements.

All component parts are installed in the manhole beneath the surface of the street so that no permanent barricades are required. And since the measurements are recorded automatically by the stylus, the workers only have to check the operation once every 24 hr as compared with measurements that had to be made physically every hour under the old method. At the end of this 24-hr cycle, the completed graph is removed, a new one installed, and the instrument is ready for another full day of operation. ▲▲



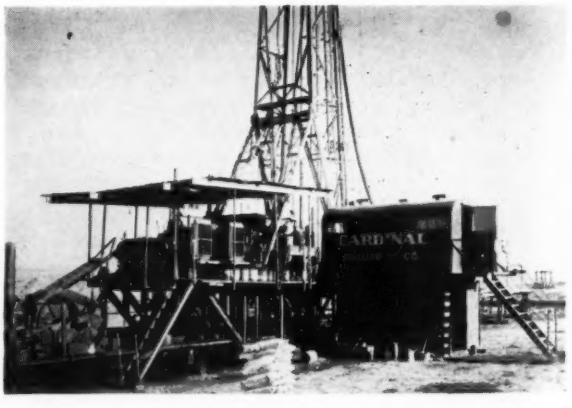
Fully Automatic Equipment Featured at New Plant

Significant feature of the addition to Dixie Guano Company's fertilizer-manufacturing plant at Laurinburg, N. C. is fully automatic equipment which will enable one man to fill the entire bulk storage area with 12,000 tons of bulk mixed fertilizer during seasonal lulls.

The 39,000 sq ft plant (right) designed and fabricated by Luria Engineering Co. is of standardized steel-frame construction covered with corrugated asbestos-cement.

The eight foot wide overhead bridge encloses a system of conveyor belts that transport bulk mixed fertilizer from old to new plant. Shuttle conveyor belts in a ten ft wide roof monitor at the new plant receive and discharge fertilizer. The addition has sections for handling screening, mixing, packaging, and shipping.

Excavation and foundation work were by Southeastern Construction Co.; erection by E. W. Hurst Co.; and Matthews & Hollis, engineers. ▲▲



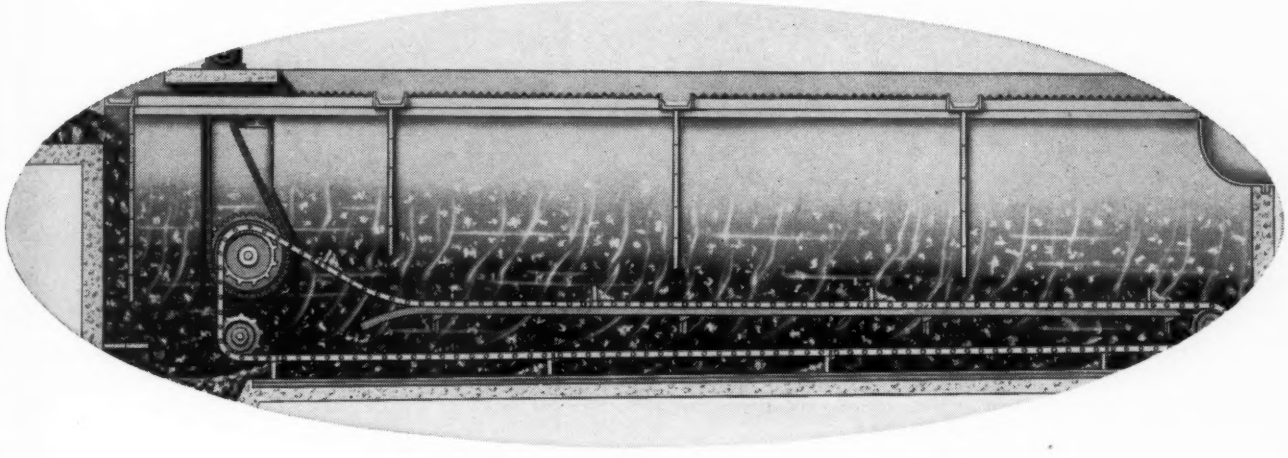
Use of Diesels Increases Efficiency of Drilling Rigs

Use of two diesel engines, in place of four butane gas-burning engines on one of the Cardinal Drilling Company's rigs, has increased average footage drilled per day and also decreased fuel costs.

The diesels were found to be more adaptable for heavy duty drilling and their use eliminated down time caused by fuel-freezing.

Although LP gas could be purchased in that

Now there's PROOF That REX® VERTI-FLO® will INCREASE plant capacities CUT installation and operating costs



Yes, the unique cellular construction of Rex Verti-Flo that provides maximum practical weir length is now an established, proven principle in clarifiers... proved in more than 20 installations with more going into operation soon! It has more than lived up to our claims ... just check any user. We'll gladly supply the names if you desire.

So, if you're interested in at least doubling your present plant capacity or substantially reducing costs of a new installation, be sure to consider Rex Verti-Flo.

Check these Verti-Flo advantages for your plants:

- Detention periods ¼ to ½ shorter than those required in conventional tanks... tank sizes ¼ to ½ of those normally used.
- Completely adaptable for varying rates of flow.
- Virtually eliminates short circuiting.
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- Maximum clarity of effluent.

For the complete Verti-Flo story send for your copy of Bulletin No. 52-77. Write Chain Belt Company, 4609 W. Greenfield Ave., Milwaukee 1, Wis.

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Diesels Increase Efficiency

—*Starts on page 64*

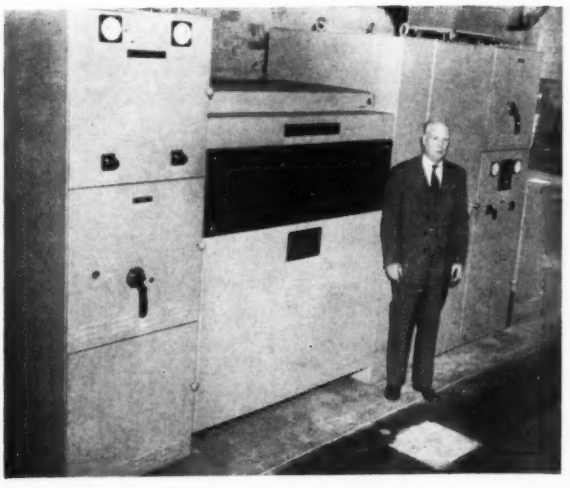
locality for about five cents less per gallon than diesel fuel, a 335-gal daily decrease in the amount of fuel used resulted in a 40 percent reduction in fuel costs. The figures were based on the operation of two General Motors 6071 diesels installed over a year ago which had drilled 24,000 feet in 2100 hours at the time of the report. ▲▲

Extra-Translucent Contact Paper Gives Faster Print Back

Extra-translucent, extra-durable contact paper designed to give faster print back speeds when diazo or blueprint reproductions are made, has been developed by the Eastman Kodak Co.

The paper, Kodagraph Contact Paper Translucent, is said to withstand considerable handling and use. Photographic lines on the paper can be erased with an ordinary pencil eraser after the paper is moistened slightly.

Emulsion is the Kodagraph Contact emulsion which produces dense black photographic lines that are clean, sharp, and legible. The paper is designed for processing in the same manner as all other Kodagraph Contact papers.



Rectifier Unit Replaces Diesel Generator Sets

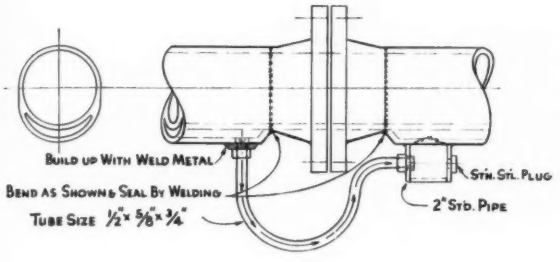
The New York, Ontario & Western's recently installed General Electric mercury arc rectifier has been saving the company over $1000 a month in operating costs, according to G. Bennett, chief of motive power for the company, shown here in front

Diesels Replaced

—*Starts on page 66*

of the new unit. The rectifier unit replaces two diesel generator sets and associated control panels in the railroad's main shop at Middletown, N. Y.

Because it has the overload capacity to handle peaks, the rectifier's installed capacity could be less than that of the old equipment. ▲▲



Steam Line Is An Integral Part Of Pipe

Piping users who handle sluggish chemicals such as tar and pitch or tricky solutions such as ammonium nitrate need heated lines to prevent their products from solidifying or crystallizing in the line. In contrast to normal methods of heating lines by using an external steam jacket or steam tube to apply the necessary heat, extruded steam traced aluminum pipe, Unitrace, is so produced that the steam line is an integral part of the pipe.

The piping is the result of joint engineering efforts by Alcoa and Hercules Powder Co.

In its original application, it resulted in the following savings over conventional two inch steam jacketed lines: 38¢ a ft saved on material; 5¢ a ft saved on insulation; and 30 percent reduction in labor costs.

Pre-formed insulation will fit Unitrace. In the case of the two inch pipe, the new product is designed so that insulation for 2½ in. standard pipe will form naturally. When insulation is used, a smaller size can be used than with the older steam-jacketed piping. But because of improved efficiency, thermal insulation will be unnecessary in many cases, particularly where set quantities of process steam are allocated for tracing purposes.

Extruded as a single unit from Alcoa 3S-F aluminum alloy, it is presently available in standard two inch pipe size without die charge. Further information is available from Alcoa sales offices or from Aluminum Company of America, 720 Alcoa Building, Pittsburgh 19, Pa. ▲▲

MEN IN ENGINEERING

★ Donald R. Whitlock, senior engineer with Singmaster & Breyer, New York, discussed "Lead in Chemical Construction" at the 26th Annual Meeting of the Lead Industries Asso. in Chicago.

★ William Balderston, president, Philco Corp. is re-elected to the National Industrial Conference Board.

★ Curtis H. Barker, Jr. joins John L. Schwab & Associates as director of materials handling activities. A former national chairman of the Materials Handling Division of the American Society of Mechanical Engineers he was formerly with the Porter-Cable Machine Co.

★ Chairman of the Joint Research Committee on Boiler Feedwater Studies is Robert C. Adams, superintendent of the chemical engineering laboratory at the U. S. Naval Engineering Experiment Station at Annapolis. He succeeds Everett P. Partridge, director of Hall Laboratories, Inc.

★ Officers of the Associated General Contractors of America, Inc., for 1954 are: president, John MacLeod, Macco Corp; vice president, George C. Koss, Koss Construction Co.; secretary-treasurer, William Muirhead, Wm. Muirhead Co.

★ The newly created Titanium Analysis Section of the Chemical Div. of Sam Tour & Co., Inc. is now in a position to handle requests for routine and control analyses of titanium metal and alloys.

★ The College of Engineering at Cornell University has been selected as a participant in the annual $12,000 Dravo Corp. scholarship program in which four schools now are sharing. The program provides for two $1000 scholarships in each university each year, and two additional grants of $500 to the university itself.

★ The Engineering Societies of New England presented the New England Award for 1954 to William F. Ryan, engineering manager of Stone & Webster Engineering Corp., in recognition of his professional attainments.

★ Carl S. Reed announces his retirement as chairman of the board of directors of The Lummus Co.

★ Holmes and Narver, Inc., Los Angeles, is awarded a contract for the engineering design of an air force assembly and test facility at Tucson, Arizona estimated to cost $2 million. Contract was awarded by Hughes Aircraft Co. which holds the prime operating contract with the Air Force at Tucson.

★ John E. Stark joins McKinsey & Co. as a consultant on personnel relations in the New York office.

★ In order to offer engineering combined with industrial design "in one package," Frank Mayer Engineering Co. of Los Angeles has organized a department of Industrial Design Engineering.

★ The consulting engineering firm of Michael Baker, Jr., Inc., has been

U.S.-AUSTRALIAN VENTURE

★ Shown at the initial official signing of a $60 million contract between the Snowy Mountains Hydro-Electric Authority of Australia and a group of U. S. contractors are, left to right: K. E. Andrews, liaison engineer between the Australian government and the U. S. Bureau of Reclamation; Alex McEachern, president, General Construction Co.; George Havas, vice president and general manager, Kaiser Engineers; and Senator A. M. McMullin, president of the Australian Senate.

Kaiser Engineers Div. of Henry J. Kaiser Co. are sponsors of the joint venture group which includes: General Construction Co. of Seattle; Walsh Construction Co., New York; Bates & Rogers Construction Co., Chicago; and Arthur A. Johnson Corp., New York.

John Tacke, resident manager for Kaiser Engineers on its $110 million construction contract at Hanford Plutonium Works, will head the joint venture. Stanley Kimball will be elevated to resident manager at Hanford and M. L. Fulton will be new assistant resident manager at Hanford.

J. Tacke

S. Kimball

M. L. Fulton

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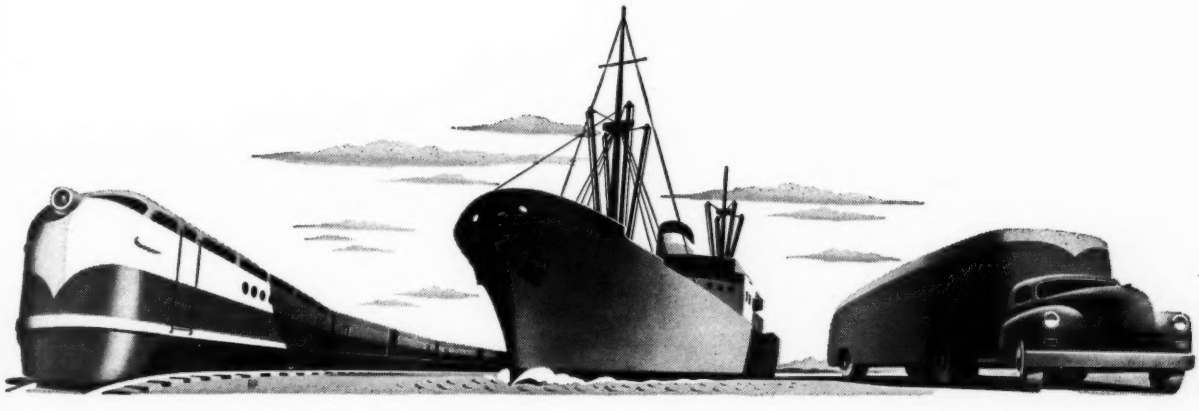

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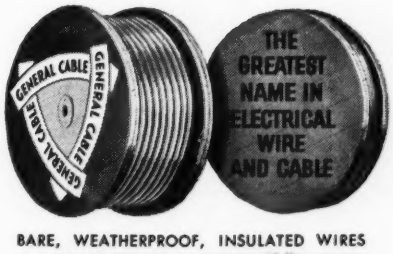
It is the simple objective of General Cable *service* to make our products both easy and pleasant for you to buy. We do it with more than 650 courteous, well-informed distributors. We do it with over 600 stock distribution points and 12 warehouses. We do it with 27 sales offices, plus 14 helpful resident salesmen. We do it with 6 strategically located manufacturing plants. This is a combination unmatched in the industry. We invite you to try it!



BARE, WEATHERPROOF, INSULATED WIRES and CABLES FOR EVERY ELECTRICAL PURPOSE

GENERAL CABLE CORPORATION 420 Lexington Avenue, New York 17, New York

Sales Offices: Atlanta • Buffalo • Cambridge (Mass.) • Chicago • Cleveland • Dallas • Detroit • Greensboro (N. C.) • Houston Indianapolis • Kansas City • Los Angeles • Milwaukee • Minneapolis • New York • Newark (N. J.) • Philadelphia • Pittsburgh • Portland (Ore.) • Rome, N.Y. • Rossmoyne, O. (Cincinnati area) • St. Louis • San Francisco • Seattle • Syracuse • Tulsa • Washington, D. C.

MEN

—Starts on page 70

awarded two contracts for aerial mapping of 84,000 square miles of Oregon and Idaho by the Army Map Service as part of a topographic map compilation project in the western United States.

★ Walter Kidde Constructors, Inc. has completed plans for construction of a 61,500 sq ft plant to house a wholly owned subsidiary, Kidde Precision Tool Corp. The building was engineered and will be built by Kidde.

★ The Board of Supervisors has approved plans drawn by Francis H. Bulot, Consulting Engineers, Inc., on the second of three major storm drain and flood control projects in Pomona, California.

★ Frederick J. Mayo, an officer of F. H. McGraw & Co. becomes executive vice president to fill a post vacant for several years.

★ Nelson S. Hibshman took office May 1st as secretary of the American Institute of Electrical Engineers. Formerly assistant secretary, he succeeds H. H. Henline, who has held the post since 1932.

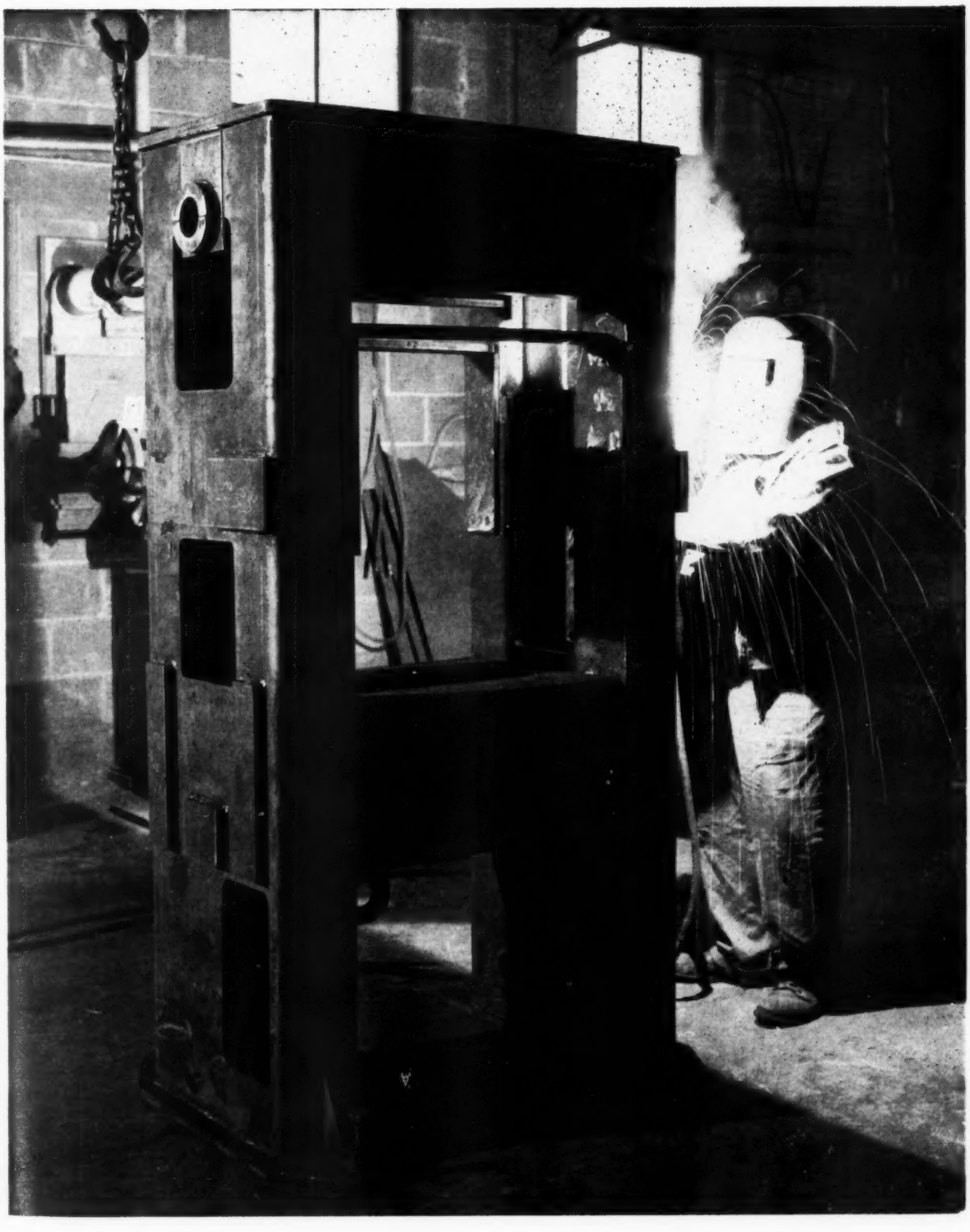
★ Ebasco Services Inc. has assigned Robert Easterly to its Chicago office to represent the company in new business development.

★ Foster D. Snell, Inc., announces the promotion of Dan Schoenholz to director of the product development department. Bernard Berkeley will act as assistant director of the department. In charge of process design will be Gabriel Appleman and S. E. Taub will handle purchasing and pilot plant operations for Hull Co., Foster D. Snell Research, Inc.

★ The Kuljian Corp. will design and construct the building for the first two units of a planned $45 million power plant in Caracas, Venezuela. To be known as Planta Tacoa, the new generating plant eventually will double the existing power potential in the Venezuelan capital.

★ Appointment of Charles C. Hornbostel as administrative assistant to the president is announced by Earle W. Mills, pres, Foster Wheeler Corp.

★ At the Research and Development Center of The Babcock & Wilcox Co., P. R. Grossman is appointed chief research engineer; A. F. Boehm, manager of facilities; G. A. Watts, superintendent of products section; J. F. Wachunas, superintendent of technical services section; W. O. Stone, Jr., purchasing agent.



BETTER PRODUCTS AT LOWER COSTS - *by fabrication*

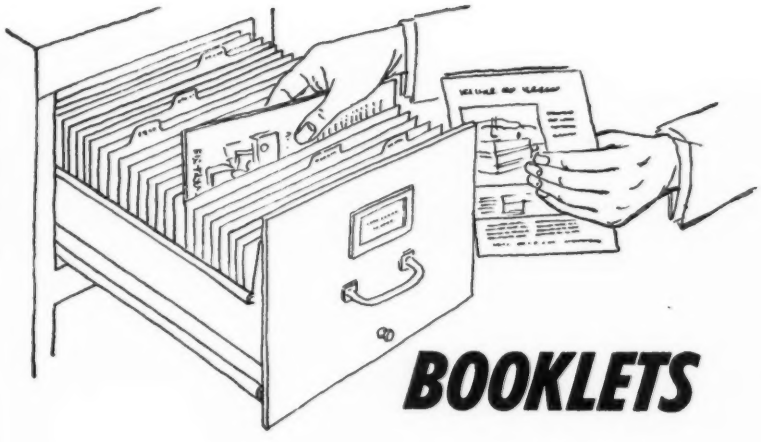
Photo above is all-steel punch press frame. Tho a third lighter than expensive castings it replaced, greater strength and rigidity of welded construction enable punch press to operate 50% faster.

Besides basic saving of material, plus values are reduced freight and handling costs, easier machining qualities. And future design changes can be made at nominal cost.

Because steel can be formed or cut into almost any size, shape or thickness, doubtless some of your own castings can be replaced by fabricated steel, at really worth-while savings.

Send us a print or a sketch of your product. Or if you wish our engineer will call on you. No obligation in either case.

THE FOSTER COMPANY, Saint Joseph, Mich.



BOOKLETS

"INSTRUMENTATION," quarterly external house organ, contains the most recent and valuable information on industrial measurement and control written by engineers in the field. This company will be glad to put your name on their mailing list to receive issues as they are published. *Minneapolis-Honeywell Regulator Co., Dept. CE, Wayne and Windrim Avenues, Philadelphia 44.*

METAL CHAIN—"Why You Should Use Rex Z-Metal Chain," 10-page booklet 53-56, gives results of laboratory tests and field applications under severe service conditions. Tables compare mechanical properties and corrosion resistance of Z-Metal with malleable iron and stainless steel. Types of chains are pictured. *Chain Belt Co., Dept. CE, Milwaukee 1, Wis.*

"MOISTURE CONTROL in Compressed Air," four-page brochure, discusses types and quantities of impurities and methods for their removal. The Vi-Speed method, units, and dessicant are clearly described along with results that can be anticipated. Specifications are listed for four models of the self-cleaning process. *Van Products Co., Dept. CE, 3791 W. 12th St., Lkwd., Erie, Pa.*

ENGINEERING PROPERTIES of "S" Monel, an age-hardenable casting alloy that provides unusual strength, hardness, and anti-galling properties at temperatures up to 1100 F, are discussed in seven-page pamphlet 2795. This booklet provides handy reference material. *Technical Service Section, International Nickel Co., Development and Research Div., Dept. CE,67 Wall St., N. Y. 5, N. Y.*

"HEAT TREATING Aluminum Alloy," 119-page manual, explains, on two different levels, the principles and procedure for heat treating. The first, in easily understandable concepts, gives a basic understanding of aluminum metallurgy. The second is a more technical discussion for highly trained engineers and metallurgists. *Reynolds Metal Co., Dept. CE, 2500 S. 3rd St., Louisville 1, Ky.*

PLANNING COMMERCIAL and industrial circuit-breaker panelboards is discussed in 16-page booklet B-6098 including advantages of De-ion circuit breakers, and of the dead-front breaker panel to both user and contractor. A new panelboard specification—considerably shorter and less time-consuming than the older type—is suggested. *Westinghouse Electric Corp., Dept. CE, P. O. Box 2099, Pitts. 30, Pa.*

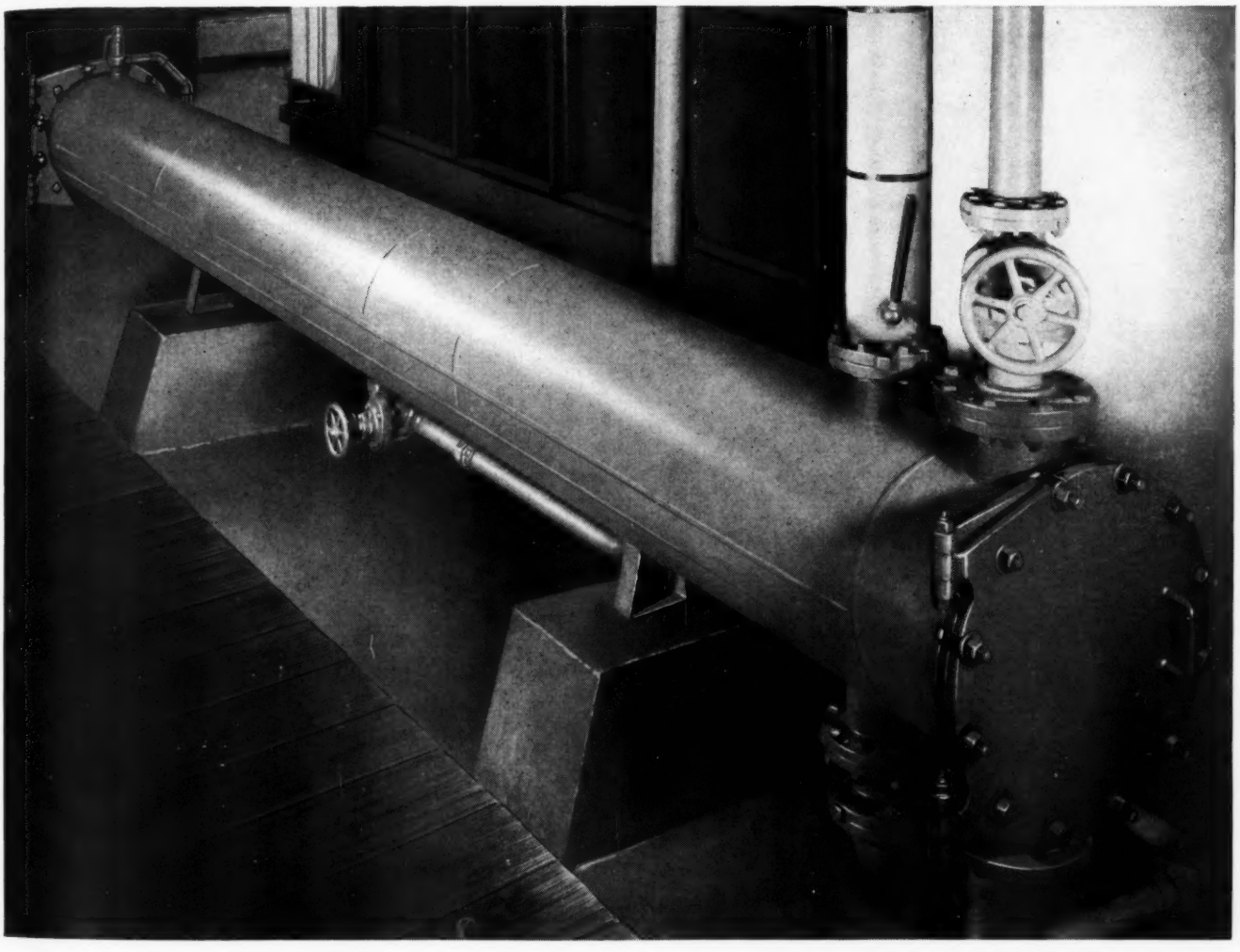
"REYNOLDS ARCHITECTURAL ALUMINUM," 16-page brochure B2-12-1053, presents the advantages of aluminum, pictures many standard designs of doors, windows, siding, and other uses, and discusses fabricating operations. A listing of available booklets and films is included. *Reynolds Metals Co., Dept. CE, Desk PR, 2500 S. 3rd St., Louisville 1, Ky.*

WATER TREATMENT for cooling towers is the subject of six-page bulletin 28X7501A. It discusses types of cooling systems together with such problems as corrosion of metal surfaces, inorganic scaling, organic growths such as algae and bacterial slime, and delignification of the wood in the tower. Information on the selection of chemical treatment is included. *Allis-Chalmers Mfg. Co., Dept. CE, 943 S. 70th St., Milwaukee.*

"ALLEGHENY METAL in Chemical Processing," is a completely revised 34-page book covering the use of stainless steel in the manufacture of

Personal copies of booklets can be obtained by writing directly to the manufacturers

Banner Yarn Dyeing Corp.



25,000 gal/hr of city water passes through this p-k reclaimer, is heated from 46° to 105°, free of cost.

saves 25% fuel costs with a p·k waste water heat reclaimer

Passing hot spent dye liquors through a **p·k** waste water heat reclaimer saves 25% of fuel costs, reports Banner Yarn Dyeing Corp., Brooklyn.

At Banner Yarn, for example, city water comes into the plant at 46° or lower. Once through the heat reclaimer, the incoming cold water temperature is raised, without cost, to approximately 105°. The **p·k** reclaimer shown has been in continuous operation for over seven years and requires a one hour cleaning job only 3 or 4 times a year. During average operation, Banner's oil heating facilities use 4000 gallons every 24 hours, 25% less than before installing the **p·k** waste water heat reclaimer.

Such savings are *usual* for owners of **p·k** heat reclaimers. Passing waste hot water through **p·k** reclaimers costs nothing after units are installed, pays off every day thereafter.

p·k heat reclaimers are available in many standard sizes and types, each specifically designed to do the best job for you. Write for fact-packed brochure that gives all details, **p·k** No. 310.

the **Patterson-Kelley Co.,** *inc.*

1750 Burson Street, East Stroudsburg, Penn.

2818

101 Park Avenue, New York 17 • Railway Exchange Building, Chicago 4 • 1700 Walnut Street, Philadelphia 3 • 96-A Huntington Avenue, Boston 16 • and other principal cities

BOOKLETS —*Starts on page 74*

acids and other chemicals, in the general process industries, in the plastics industry, in pharmaceutical manufacture, in dye making, and in soap making. Also included are corrosion resistance data, fabricating information, and a stainless steel finder. *Advertising Dept., Allegheny Ludlum Steel Corp., Dept. CE, 2020 Oliver Bldg., Pitts. 19, Pa.*

POCKET-SIZE, ten-page illustrated booklet entitled "Better Concrete Faster" gives a concise and detailed account of the facts on how the addition of calcium chloride to the mix results in better, faster, and more economical concrete construction. Easy-to-follow use instructions are also included. *Inorganic Sales Dept., The Dow Chemical Co., Dept. CE, Midland, Mich.*

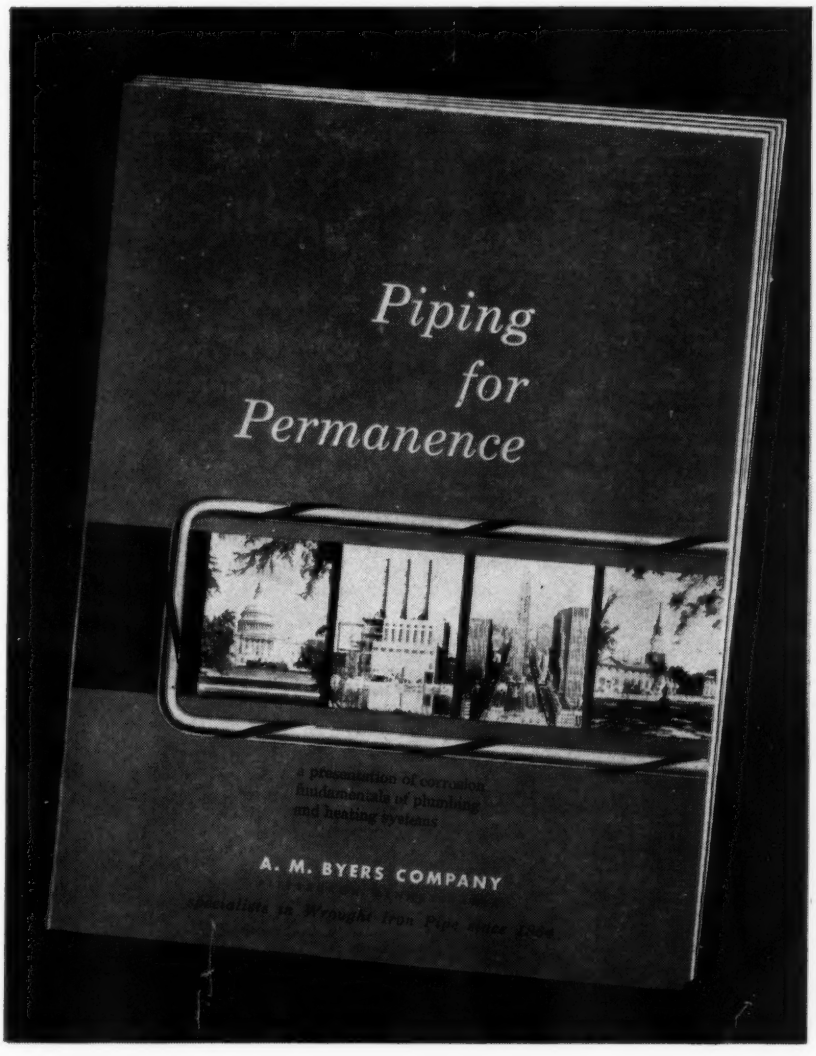
REVISED SECOND EDITION of the Engineering Data Book on Pipe and Fin Coils contains such information for the design engineer as design and calculation of pipe and fin coils, heat transfer coefficients for heating or cooling, factors for computing fin coil surfaces, recommended materials for heating or cooling, heat transfer factors at various air velocities, and Btu load limitations for cooling coil circuits. *Rempe Co., Dept. CE, 364 N. Sacramento Blvd., Chicago 12, Ill.*

BOILER-BURNER unit described in 16-page brochure 502 is the result of the engineering talents of these two companies. The booklet explains how the boiler and burner are designed to provide a completely automatic, ready to install unit. Multicolor drawings show component parts and engineering data are incorporated in table form. *Kewanee-Ross Corp. and Petro Div., Dept. CE, 3170 W. 106 North, Cleveland 11.*

INDUSTRIAL CONTROLS, non-indicating, non-recording for regulation of simple processes which do not warrant use of the more complex and expensive instruments, are fully listed and described in 80-page catalog 8305-R. Representative applications suggest ways in which these controls may be used in your client's plant. *Minneapolis-Honeywell Regulator Co., Industrial Div., Dept. CE, Wayne and Windrim Ave., Phila. 44.*

Your copy is ready

...PIPING FOR PERMANENCE



The nature of piping problems in heating and plumbing systems, and the methods by which they can be solved, are discussed in detail in this 32-page Bulletin.

Prepared by our Engineering Service Department, this Bulletin is based on the information we have gathered from analysing complete data on thousands of piping installations of every type, under all kinds of conditions. This pool of experience has been condensed between covers in a clear, easily followed story to help you realize greater piping economy in your installations.

The bulletin also includes a roundup of wrought iron pipe installations from every part of the country and presents practical evidence of the results obtained from the use of the material. These past service records are providing leading engineers everywhere with a practical guide for today's selection.

Your copy is ready. Write for it today.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. Export Dept.: New York, N.Y.

You'll find information on:

Requisites of a piping system—brief review of piping material properties essential to long-life, economical service.

Building-piping systems—definition of individual services; brief discussion of conditions that threaten service life in plumbing and heating systems and solutions; fundamentals of design and installation that may be used to reduce the rate and severity of corrosion.

Water and water problems—background facts on interpretation of water analysis and water treatment.

How Byers can help you—available data on piping installations to solve individual problems; how you can benefit from the records of our Engineering Service Department.

BYERS

CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

BOOKLETS —Starts on page 74

MOTOR FRAME CHART—To dispel any possible confusion over old and new mounting dimensions, this company has produced the "Compar-A-Frame" chart to aid engineers and designers in quickly comparing the old and new NEMA a-c frame assignment standards. It shows at a glance comparative dimensions of open type and fan-cooled polyphase induction motors. *Reliance Electric & Engineering Co., Dept. CE, 1088 Ivanhoe Rd., Cleveland 10, Ohio.*

SILENT CHAIN—One of the most comprehensive books developed on silent chain, 88-page bulletin 2425 contains detailed engineering data. Pre-engineered stock drives for normal requirements are listed. A complete section outlines selection procedure. Complete operational and technical data, such as installation, maintenance, and lubrication procedures, are also given. *Link-Belt Co., Dept. CE, 307 N. Michigan Ave., Chicago 1, Ill.*

DOOR CATALOG—Information valuable to engineers, architects, and building management executives, such as designs for turn-over, bi-fold, and telescoping canopy doors and vertical lift, slide, turn-over, and special-purpose doors is given in this 15-page catalog. Construction and operational details are shown in drawings. *International Steel Co., Dept. CE, Evansville, Ind.*

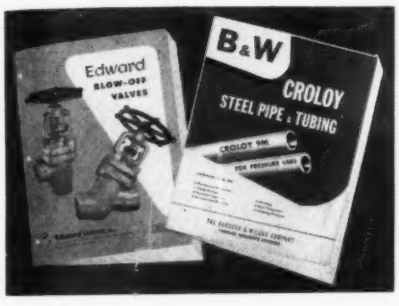
DRY FILM LUBRICATION—The latest answers for the solution of difficult lubrication problems due to extreme heat, excessive cold, inaccessibility, high speeds, high loads, galling, seizing, and excessive wear are presented in this file folder. How dry film lubricants solve problems where other lubricants fail is told by means of case histories. *Electrofilm, Inc., Dept. CE, P.O. Box 106, North Hollywood, Calif.*

PIPELINE applications of Calrod tubular heaters in industry are shown in photographs and drawings in eight-page bulletin GEA-5095A. A comprehensive chart gives heat losses of vertical, solid, and smooth surfaces of metals. *General Electric Co., Dept. CE, Schenectady 5, N. Y.*

ARCHITECTURAL USE of aluminum as an exterior wall facing material is detailed in drawings which illustrate outstanding achievements in recent construction with aluminum. The shop or erection drawings show how the various types of aluminum panels are installed. The first four drawings available are Fort Couch School, Pittsburgh; Tishman Building, New York City; Bradford Hospital. Bradford, Pa.; and the Wyatt Building, Washington, D. C. *Aluminum Company of America, Dept. CE, 1501 Alcoa Bldg., Pitts. 19, Pa.*

VIBRATION PROBLEMS—Actual on-the-job photos and case histories showing how representative diesel and gas engine vibration problems have been solved with effective vibration control are included in catalog PS-4. Installations featured range in size from a 16 hp diesel generator set on a truck up to a series of six 1425 hp supercharged diesels at a power plant. It explains how correctly engineered vibration control can in many cases permit engine installations without special foundations. *The Korfund Co., Inc., Dept. CE, 48-48B 32nd Pl., Long Island City, N. Y.*

ONE OF THE ALLOY tubing steels widely used in elevated temperature service is discussed in technical data card TDC-151. Known as B&W Croloy 9M (8 to 10 percent chromium, 1 percent molybdenum), tubes of this alloy have been used successfully in a wide variety of petroleum conversion equipment. Included in the bulletin are data on mechanical and physical properties, bending, welding, and heat treatment. *Tubular Products Div., Babcock & Wilcox Co., Dept. CE, Beaver Falls, Pa.*



BLOW-OFF VALVES — Catalog 12-D1 features a redesigned line of blow-off valves with flanged or welding ends and bolted bonnets for 300, 400-600, 900-1500 lb sp classes plus the addition of welded bonnet blow-off valves with welding ends for 1500 and 2500 lb sp classes. Two pages are devoted to tips on selection, operation, installation of blow-off valves, and the boiler code requirements for them. *Edward Valves, Inc., subsidiary of Rockwell Manufacturing Co., Dept. CE, 1211 W. 145th St., E. Chicago, Ind.*

DUAL FUEL ENGINES—In 36-page bulletin S-500-B57, are photographic examples of each application, together with vital statistics, case histories, and comments on fuel consumption for dual fuel engines. Each feature is treated separately: the dual plunger fuel injection pump; automatic fuel switcher; automatic thermal air control; and the Micrometering gas valve. *Worthington Corp., Dept. CE, Harrison, N. J.*

HEAT EXCHANGERS — Bulletin 120 describes the operation of the Aero Heat Exchangers used in cooling or controlling of temperatures of industrial liquids. It shows the operation of this equipment by means of diagrams and examples of application by installation photographs. *Niagara Blower Co., Dept. CE, 405 Lexington Ave., N. Y. 17, N. Y.*

INDUSTRIAL FANS — Helpful information concerning cooling and drying problems, system ventilation, and open surface tank ventilation is included in 11-page booklet 650 on Type CS Tubeaxial and Type CSB Stackbooster fans. Full page chart can be used to figure duct resistance. *Propellair Div. of Robbins & Myers, Inc., Dept. CE, Springfield, Ohio.*

Timber Construction

—Starts on page 37

trusses are Pratt, Howe, and Warren. As with pitched trusses, the Pratt system has the advantage of keeping the length of compression web members to a minimum. This system is desirable when trusses have a multiple number of members and are built integral with the timber columns. If the trusses are to be supported on walls or on corbels attached to the columns, however, the Howe system is desirable providing the compression members do not require excessive sizes, since the web member stresses will be smaller than for the Pratt system.

The simple Warren web system is most desirable for smaller span trusses where the depth of truss is considerably less than the panel length, since it provides more nearly balanced web member stresses. It is also used, with vertical members added, for long span flat trusses although the concentric framing of three web members to the same point on the bottom chord sometimes presents a design problem unless gusset plates are used.

Spacing

Spacing of trusses is affected by the type of roof framing, type of wall construction, size of material available, and the loading conditions. In general, greater spacing will be more economical, and the larger the span the more desirable a larger spacing —up to the limit of available purlin or joist sizes to frame between trusses.

Frequently spacing is more or less arbitrarily chosen to work well with the roof and wall construction or building use. Thus, if masonry walls are used, spacing is often chosen to fit the required pilaster spacing for the lateral support of the masonry. If roof sheathing material is to be applied directly to the trusses without auxiliary framing, which saves labor in placement of purlins, the spacing should be about two feet with one-inch sheathing, four feet with five-quarter sheathing, seven or nine feet with two-inch plank, and even greater spacing when heavier planks are used.

Where joists or purlins are used between trusses, the spacing can be determined by desirable joist sizes, although the most widely used spacing is probably in the range of fourteen to twenty feet. Where spacing greater than suitable for sawn purlins is desired, glued-laminated purlins or trussed purlins can be used.

In recent years there has been a trend away from the use of rafters with purlins and towards the use of closely spaced purlins or joists along the top chord. This reduces the space above the truss, gives better lateral support to the top chord, saves labor in placing the rafters, and usually permits the use of smaller joists or purlins.

Maximum Spans

Such factors as the type of material available, loading conditions, spacing, and type of truss determine the maximum economical span for any given timber truss design. For average loading and spacing of fifteen to twenty feet, pitched and flat trusses are seldom used for spans in excess of eighty feet. Economical spans are usually limited by sizes and lengths of solid timber available, and by the capacity of the web member connections.

Bowstring trusses, on the other hand, have a wide economical range, varying from 30 feet to more than 200 feet. Trusses using glued-laminated members are usually shop fabricated and are not recommended for field fabrication except where competent supervision is provided and essentially the same quality control applied as under shop conditions. Since many fabricators have standardized on the bowstring type, it is advisable to provide an alternate using a bowstring truss, even though the original design may show either a flat or pitched type of truss.

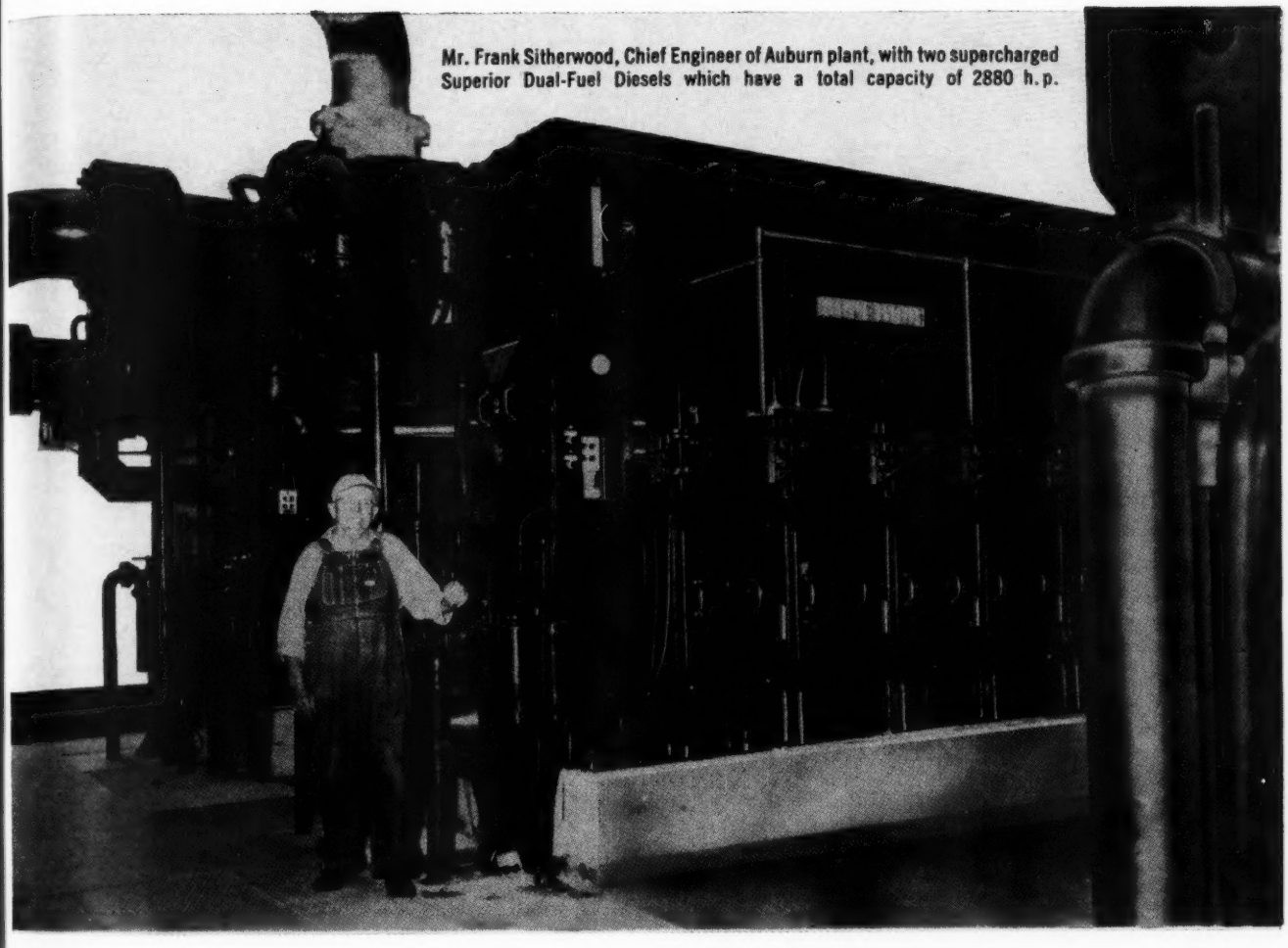
Light trusses such as trussed rafters on 2- to 4-ft spacing are recommended for spans up to about 50 feet. They can be built for longer spans, but a heavy truss with larger spacing is usually more economical. Trussed rafters offer advantages in that they require small, readily available sizes of lumber, they are easy to fabricate, and they are relatively lightweight for easy handling and erection.

Glued-Laminated Timbers

The use of glued-laminated timbers has opened up a new field for wood—that of long span arches. Formerly these arches were constructed almost entirely from steel or reinforced concrete. Smaller span decorative arches for churches and similar structures also are being fabricated from glued-laminated timbers.

Like trusses, arches provide large clear span areas and, in addition, provide high headroom clearances without unduly high side walls. In effect, they provide the structural framework for the roof and sidewalls all with one member. Thus, when high ceiling height is required, arches can be the most economical type of construction.

Glued-laminated arches are of three general types: tied arches, two-hinged, or three-hinged. Selection depends upon the general shape desired and the method of support. Most low rise arches are two-hinged or tied arches, the latter being used when it is undesirable or uneconomical to provide thrust resistance in the walls. High rise, Tudor, and



Mr. Frank Sitherwood, Chief Engineer of Auburn plant, with two supercharged Superior Dual-Fuel Diesels which have a total capacity of 2880 h.p.

Auburn, Nebraska, pays off power plant debt

5 years ahead of schedule!

This year, the Board of Public Works of Auburn, Nebraska, plans to pay the last $76,000 of a bonded debt which totaled $279,000.00, five years ago. This final payment is five years ahead of schedule, for which the Board gives credit to a pair of Superior Dual-Fuel Diesels.

The first Superior, originally a straight diesel rated at 960 h.p., was installed in the power plant in 1946. Dual-fuel equipment was added in 1948, to enable the engine to operate on diesel or natural gas, depending on supply and price.

The following year, the Board produced 190,000 *more* kilowatt hours of electricity for 21,800 *less* dollars. Fuel savings accounted for all but $250 of the total cost reduction!

When Auburn's generating capacity had to be increased in 1949, the Board bought a new Superior supercharged dual-fuel diesel—for obvious reasons—and in 1952, added a supercharger to the first one.

This is just one example of the many outstanding economy records made by Superior and Atlas Diesels. You can easily get more information on the engines to profitably meet your power needs by calling the nearest sales and service office listed below.

DIESEL DUAL FUEL GAS — THE NATIONAL SUPPLY COMPANY — ATLAS Imperial DIESEL ENGINES — Superior ENGINES — DISTRIBUTOR OF Lister DIESELS IN U.S.A.

THE NATIONAL SUPPLY COMPANY

ENGINE DIVISION PLANT AND GENERAL OFFICES: SPRINGFIELD, OHIO

SALES AND SERVICE POINTS: Gloucester, Massachusetts • Houston, Texas • Fort Worth, Texas • San Diego, California Oakland, California • Terminal Island, California • Ketchikan, Alaska • Washington, D.C. • Chicago, Illinois • Portland, Oregon • Astoria, Oregon • Casper, Wyoming • Halifax, Nova Scotia • Vancouver, B.C. • Toronto, Ontario • Park Rapids, Minnesota • New York, New York • Seattle, Washington • New Orleans, Louisiana • Pittsburgh, Pennsylvania

Gothic arches are usually of the three-hinge type.

The selection of proper spacing of glued-laminated arches is dependent on the same factors as truss spacing. However, glued-laminated purlins are frequently used, permitting maximum spacing with minimum purlin size because of the higher allowable working stresses permitted in glued-laminated members.

The limitations as to span depend on three primary factors: the capability of the laminator to handle large sizes, the open and closed assembly time for the glue used, and the maximum size that can be transported. Curved members up to 120 feet in length with a 13-ft rise are possible. In addition, it is possible to design inconspicuous moment resisting field splices to handle axial loads and shear.

Glued-laminated construction also is being used for columns and beams. Simple span beams are available up to 100 feet in length. Although of higher first cost, glued-laminated columns give trouble-free service and present a most attractive appearance. These beams and columns can be made of varied cross section to achieve pleasing architectural effects.

The usefulness and importance of wood is constantly being increased by new developments. One manufacturer recently began production of glued-laminated planks of edge-glued strips which are free of warp, twist, and cup, and are stronger than a piece of solid wood the same size. Even the common 2x4, laminated from smaller pieces, someday may become a standard lumber item. ▲▲

Drawings on Microfilm

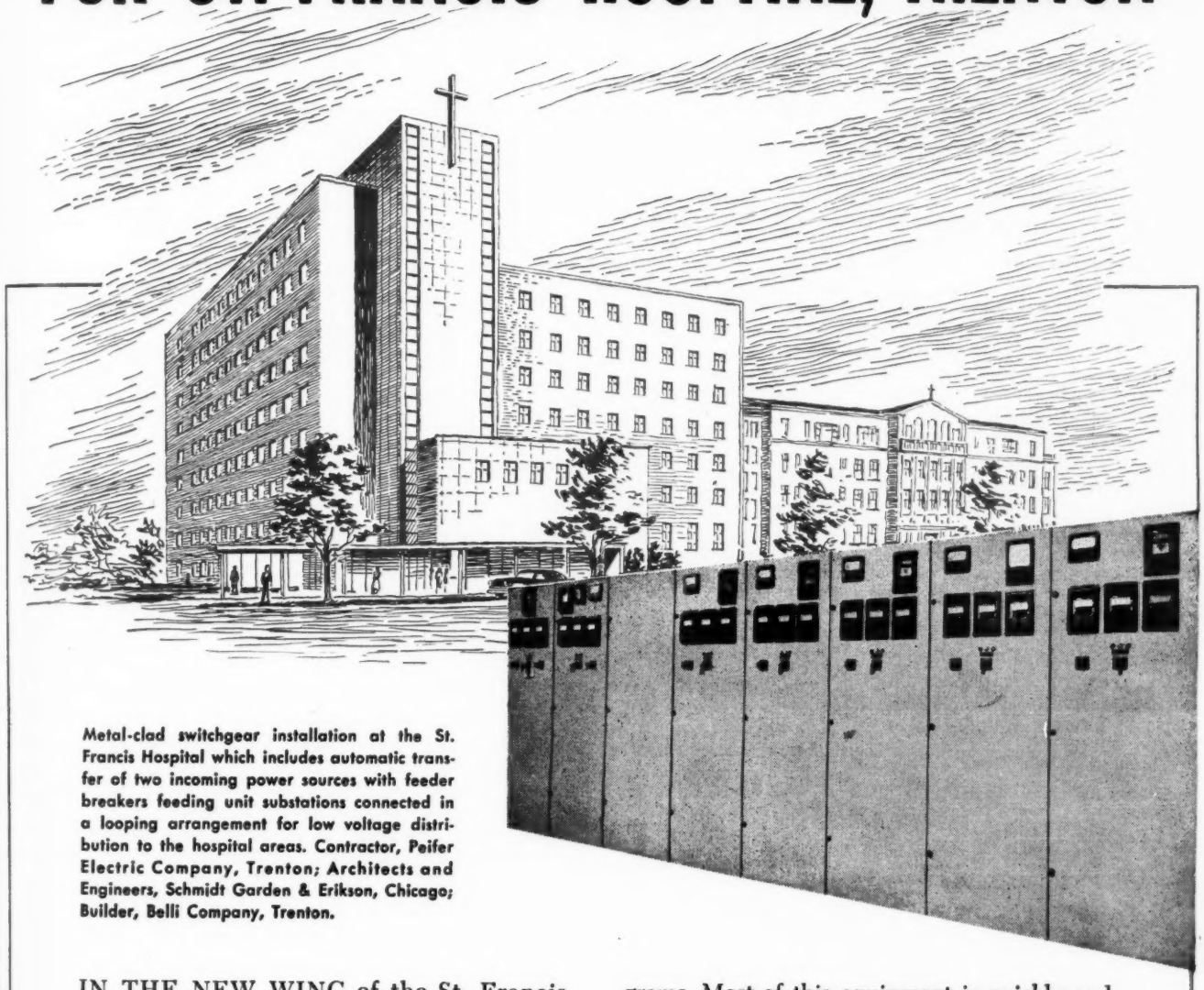
—*Starts on page 54*

contract for assumption of the total operation.

Costs are equally an individual matter. A large elevator manufacturing company established the cost of one negative copy at five cents, and the cost of one positive copy plus the individual card, mounting, and posting of identification at another five cents. These figures are based on the filming of approximately 140,000 tracings. It is unlikely, however, that any two large microfilm operations would show identical costs, since average size and condition of drawings, frequency of reference anticipated, and growth of the main file will vary.

Regardless of the quantity involved, however, the equipment and techniques necessary for efficient microfilming of engineering drawings do exist, as do the service firms to implement them effectively. This method of record-keeping should soon be as basic a procedure for engineering drawings as it has been for some time in the field of everyday paperwork. ▲▲

IT'S FEDERAL-PACIFIC SWITCHGEAR FOR ST. FRANCIS HOSPITAL, TRENTON



Metal-clad switchgear installation at the St. Francis Hospital which includes automatic transfer of two incoming power sources with feeder breakers feeding unit substations connected in a looping arrangement for low voltage distribution to the hospital areas. Contractor, Peifer Electric Company, Trenton; Architects and Engineers, Schmidt Garden & Erikson, Chicago; Builder, Belli Company, Trenton.

IN THE NEW WING of the St. Francis Hospital, Trenton, N. J., the entire electrical system is controlled by Federal-Pacific equipment. The installation includes a 5 kv metal-clad switchgear installation employing magnetic air break circuit breakers, unit substations, and necessary lighting and distribution panelboards.

Federal-Pacific electrical equipment for light and power is today's leading specification both for new construction and modernization programs. Most of this equipment is quickly and economically assembled from standard units to meet specific requirements. You can always look to it for lowest installation costs . . . and for engineering that assures top efficiency, easy maintenance, and ready adaptability for future changes or expansion.

When you have an electric distribution problem, Federal-Pacific will be glad to study it. Write Federal Electric Products Company, 50 Paris St., Newark 5, New Jersey.

FEDERAL & PACIFIC

ELECTRIC PRODUCTS COMPANY — ELECTRIC MANUFACTURING CORP.

Federal products: Stab-lok Circuit Breakers, Motor Controls, Safety Switches, Service Equipment, Industrial Circuit Breakers, Panelboards, Switchboards, Control Centers, Bus Duct — Pacific Electric products: High voltage circuit breakers and power switches ★ Sales offices in principal cities.

Air Pollution

—*Starts on page 42*

supervision are often evident. Other factors being equal, the plant with better supervision usually has better air pollution performance.

Cases in point are railroads where steam locomotives may still be used for motive power. Comparing one railroad with another, the fuel equipment, service, load demands, and manpower, may be very similar. Still, one road may have a better smoke performance than the other. In many such instances, the difference in smoke performance seems to be due to supervision. Although in some instances it appears to be more intense supervision—in others it seems to be the better quality of supervision.

To insure that all concerned are constantly on the alert towards the necessity of maintaining the best air pollution performance, good supervision is required—starting with top management and going all the way down the line.

Smoke and Business

Suppose there is a growing community in which an air pollution nuisance has developed and little or nothing has been done about it. What generally happens is that a group starts actively crusading against the nuisance. It may be a woman's club, service club, or an improvement association. Perhaps a citizens' committee has been organized. The newspapers and radio stations devote considerable space and time as the movement gains momentum. Soon there is a popular demand for the authorities to pass a law or regulation. Then, invariably, from the other side the cry is raised that business will be hurt, that industry will move away, or at least that new industry will not come in.

No instance comes to mind where an industry has moved because of legislation regulating air pollution. Moving an industrial plant is expensive. If a plant does decide to move, it may find that stricter regulations prevail in the new locality. On the other hand, an engineering survey may disclose that much of the pollution comes from sources other than industries—perhaps from home heating plants, motor vehicles, construction operations, disposal of garbage and refuse.

Advantages

Instead of driving out industry or injuring business, a well-planned and well-managed program to minimize air pollution will be helpful in attracting new plants and new business to a progressive community. Numerous examples tend to indicate that new industries and new branch plants have refused to locate in a community which has serious air pollution conditions.

The best argument to convince a reluctant management that it is to their advantage to practice air pollution control is to point out the substantial fuel savings that result with complete combustion of the fuel—at the same time eliminating excessive smoke.

Smoke from a fuel burning operation is an indication of incomplete combustion. And more often than not, the rich hydrocarbon gases in the fuel are the ones which are not completely burned. These hydrocarbons have the highest heat content of any part of the fuel. The higher the cost of the fuel, the greater can be the savings.

There are any number of instances (many of which have been published) detailing the actual savings made by various plants in their fuel consumption while at the same time lessening their smoke problem. One plant, within my knowledge, changed from hand to mechanical firing and saved the cost of the installation within a year. Certain power and heating plants have modernized their boiler plants and have realized a 15 to 40 percent return on their investment.

Public Relations

Any program to control air pollution, if it is to be successful, should have good public relations. The newspapers, irrespective of politics, can be interested in supporting the movement. News articles on progress of the work, interesting happenings, cooperation of offenders, comments from prominent citizens, ought to appear frequently. Informative talks, interviews, and panels are another form of publicity that will prove helpful. Together, these should be part of a comprehensive educational program whose ultimate goal is to educate the public as quickly as possible. The press, TV, and radio are essential mediums in promoting air pollution control.

If people are air pollution conscious, the battle is half won. By observing excessive pollution and reporting the violation to an enforcement officer, the people can help bring into line those responsible for the problem.

Partly as a result of public awareness, many plants police their own stacks. A number of railroads, public utilities, and large industries have done this for years. The duty may fall on an inspector, yard foreman, supervisor, or even the gate watchman. Whenever excessive pollution is observed, the boiler room or plant supervision is quickly notified. Self policing is very necessary since no municipality can possibly afford enough inspectors to keep all potential air pollution sources under constant surveillance. The more voluntary observers and company inspectors, the more effective will be the air pollution control program. ▲▲

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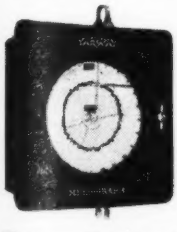
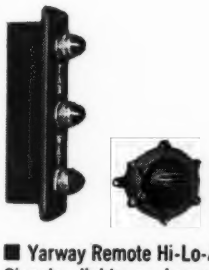


■ Yarway Hi-Lo-Graph Recorder provides not only water level indication, but also a 24-hour recording of water levels. See Yarway Bulletin WG-1830.



■ Yarway Remote Hi-Lo-Alarm Signals—lights or horns—can be placed at any location in plant. See Yarway Bulletin WG-1823.

YARWAY | ***remote liquid level indicators***

Consultant and Plant Engineer

—Starts on page 48

sick leave, supervision, stenographic and clerical services, idle time between projects, and heat, light, and rental for space occupied. Unfortunately, the consultant must charge for all of these items (but a smaller consultant may have the advantage because some of his costs are lower).

Of course, if the plant engineering department is not already loaded to the gunwales, management should consider that it doesn't cost much to load just one more job on them since they'll represent the same pay-roll whether they have the extra project or not. Nevertheless, the consultant has some potent arguments to offset his high costs. He is doing a quality job on which he is, of necessity, staking his reputation and, if he is on the ball, he should be saving the client money by good design practices. He is turning out complete drawings that allow receipt of low-cost bids for construction. He must get at a job quickly and complete it as soon as possible.

Type of Project

It should be apparent that your firm can best serve an industrial plant on a project that has certain characteristics. The project should be fairly large in relation to the size of the plant. If it is not, either the plant engineer or a small local consultant can handle it adequately and more economically. Your case will be helped if the time factor is important to the job.

The project should require real engineering, rather than just drafting-room service, and it should be an integral piece of work which will not require complicated liaison between too many departments in the client's organization. It should be in a field with which your firm is reasonably familiar. But remember, many industries have participated actively in the development of their processes and their own plant engineers may be better qualified than any consulting firm.

Consulting engineers can serve industry particularly well on projects that are broadly classed as engineering-economic studies. Consultants have several advantages over the plant engineer in this type of work, since the plant engineer is not likely to be expert in such problems as the estimating and evaluation of fixed and variable costs or the complete economic comparison of alternative plans. The consultant is in a better position than the plant engineer to take a broad view, putting first things first and subordinating details. The seasoned judgment of the top men in a consulting engineering firm can be particularly valuable when applied to the over-all conclusions of an engineering-economic report. Also, a consultant usually has the background and experience to present recommendations and conclusions to management in a form which they can understand (a faculty not always shared by plant engineers).

One point which should be borne in mind, though, is that the field of economic studies is one in which your firm can receive very effective competition from small consultants. One top-notch man and a few helpers often can do as good a job as your large firm—and with markedly lower overhead costs.

There are specific types of industrial projects on which consulting engineers can deliver effective and reasonably economical service. The following are a few: Studies of purchase versus various methods for generation of steam and electric power. Studies of purchase of fuel gas from a local utility versus generation or purchase of liquid gas. Studies of continuation versus elimination of plant direct-current electrical systems. Design of heavy power facilities; steam or steam-electric power plants, substations, large electroplating and electric furnace installations, and heavy machinery installations such as rolling mills. Foundations for large machinery, especially if vibration is to be controlled or soil conditions are poor.

Testing Facilities

When a plant's engineering department obtains authorization for new research and development facilities, a decision to have the design done by the plant engineer may be an invitation to confusion. The project will have been thought out only in general terms, and as the weeks go by, it grows and grows, and more and more changes are needed. It also gets more expensive.

On the other hand, if the job is given to a consulting engineer, the company's engineering department is forced to sit down and decide just what it wants and why. This is a valuable step for all concerned, and it saves the management a considerable amount of money. Furthermore, changes of heart in midstream are less apt to occur. There is more red tape and publicity involved in notifying a consultant that the signals have changed than there is in telling the plant engineer down the hall.

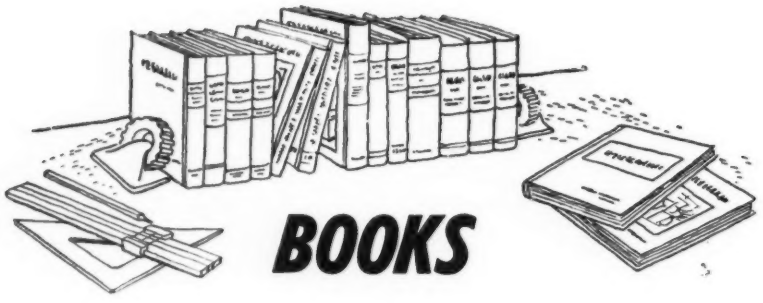
Despite the appearance of competition, you can be more of an ally to the plant engineer than a competitor. If you handle the projects in his plant for which your firm is best suited and he does the same, the plant and its management are the winners. ▲▲

This is the second article which Mr. Hitt has authored for CONSULTING ENGINEER. *His first article, "Torque and Speed in Mechanical Power Transmissions," appeared in the July, 1953 issue.*

consulting engineers' calendar

Date	Sponsor	Event	Location
May 16-19	American Institute of Chemical Engineers	Summer Meeting	Springfield, Mass.
May 19-21	American Institute of Electrical Engineers	Electric Welding Conference	Hotel Schroeder Milwaukee, Wisc.
May 17-20	Basic Materials Exposition and Conference	2nd Annual Exposition	Amphitheater Chicago, Ill.
May 23-28	American Water Works Association	National Convention	Seattle, Wash.
May 24-26	American Institute of Electrical Engineers	Conf. on Telemetering	Morrison Hotel Chicago, Ill.
June 9-11	American Society for Quality Control	8th Annual Convention	Jefferson Hotel St. Louis, Mo.
June 9-12	National Society of Professional Engineers	12th Annual Meeting	Hotel Schroeder Milwaukee, Wisc.
June 14-17	American Society of Mechanical Engineers	Oil & Gas Power Division	Muehlebach Hotel Kansas City, Mo.
June 14-19	American Society of Civil Engineers	Convention	Chalfonte-Haddon Hall, Atlantic City
June 20-24	American Society of Mechanical Engineers	Semi-annual Meeting	William Penn Hotel Pittsburgh, Pa.
June 20-25	American Institute of Chemical Engineers	Nuclear Engr. Conference	University of Mich. Ann Arbor, Mich.
June 21-25	American Institute of Electrical Engineers	Summer General Meeting	Los Angeles, Calif.
June 28-30	American Society of Heating and Ventilating Engineers	Semi-annual Meeting	New Ocean House Swampscott, Mass.
July 13-15	Western Plant Maintenance Show	Conference and Exposition	Pan Pacific Bldg. Los Angeles, Calif.
Sept. 8-10	American Society of Mechanical Engineers	Fall Meeting	Hotel Schroeder Milwaukee, Wisc.
Sept. 12-16	American Institute of Chemical Engineers	Fall Meeting	Colorado Hotel Glenwood Springs, Colo.
Sept. 12-16	Illuminating Engineering Society	National Technical Conf.	Chalfonte-Haddon Atlantic City, N. J.
Sept. 15-17	Compressed Air and Gas Institute	Meeting	Skytop Lodge Skytop, Pa.
Sept. 15-20	Instrument Society of America	International Instrument Exp.	Convention Hall Philadelphia, Pa.
Sept. 27-29	American Institute of Electrical Engineers	Petroleum Conference	Mayo Hotel Tulsa, Okla.

PROFESSIONAL LISTINGS



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HISTORY OF AMERICAN INDUSTRIAL SCIENCE by Courtney R. Hall; Library Publishers; 453 pages; $4.95.

Reviewed by Thomas P. Hughes
Dept. of Engineering
University of Virginia

Professor Hall's book is one more in an increasing number describing and interpreting the history of American industry. Until the last decade historians usually wrote of politicians, politics, and society in an effort to tell of America's past: now the accounts of inventions and inventors, businessmen and great corporations, engineers and scientists, figure prominently in the field of American history.

These "new" American histories usually fall into one of three categories: history of science, history of technology, or history of the great corporations. Hall's book is a combination of history of technology and of corporation history: a combination he styles industrial history.

The author, in order to write the story of American industrial history, has drawn upon information supplied by a number of large corporations. Insomuch as the records of most of our major corporations extend back little more than half a century, most of this history is of the twentieth century. It is a minor tragedy that so many American corporations destroyed their early records and thereby determined that the accounts of their beginnings would forever be sketchy. Today, industry is more history-conscious.

Information gathered by Hall is organized according to major divisions in the industrial picture. Transportation, chemical, electrical and communication, rubber, mining and metallurgical, feeding, cleaning, and clothing are some of the industrial fields covered. Each chapter contains material describing briefly the origins of the particular industrial field followed by short historical sketches of major corporations in the industry. What usually results is an account of the major inventions in each industry; of the most important persons associated with the industry; and of the astounding growth in diversity and quality of production.

According to the publisher and the author, a "single purpose" dominated the preparation of the history: "to help make the general public aware of the need for the continued improvement of our industrial system, along the lines of greater productivity and efficiency and into new lines of helpful development, and to tell the story in terms which most people can understand."

Professor Hall of Queen's College has written and taught history for several decades and has presented this history in a clear and orderly manner "which most people can understand"; however, it remains doubtful that "most people" as a result of reading this book will help direct our industrial system into the channels envisaged.

Such pretensions as this "single purpose" should be avoided by authors and publishers alike if industrial history is to continue in good repute and not be taken as company literature. Engineers, scientists, and managers need highly critical, nondidactic history of their predecessors and of their professions and industries so that they can draw upon the wealth of successes—and upon the wealth of failures as well—in order to plan intelligently for the future. Hill, because of the very nature of his source materials, tells little of the companies that failed and the men that erred.

Fortunately the author has not devoted too much of his energy in the attempt to direct the thinking of "most people" despite the declared intent, and what results is a readable, uncritical, and general account of the recent history of American industry as shaped by the activities of the great corporations. It is a fascinating and impressive story which might bring some of the many facets of the industrial scene into focus for engineer, layman, and industrialist alike.

INDUCTION AND DIELECTRIC HEATING, by J. Wesley Cable; Reinhold Publishing Corporation; 620 pages; $12.50.

Reviewed by John F. Dawson
Engineer-in-Charge
Induction Heating Sales & Engr.
Allis-Chalmers Manufacturing Company

This book presents much heretofore unpublished material in a very

interesting manner. The author has intentionally used very few formulas and mathematical equations.

The book is divided into two major sections—Induction Heating and Dielectric Heating. Each major section is further divided into sub-divisions in logical sequence, each relating to the major subject.

The first chapter titled "History and Present Status" is a general resume of the history and development of heat in various forms up through the advent of electricity.

The chapters on the subject of induction heating cover the theory of the subject in a general way. A description is given of equipment from the standpoint of frequency, the motor generator, spark gap, and high frequency or vacuum tube sets. Brief mention is made of 60 cycle equipment and its applications. The author covers many applications of induction heating—giving an adequate description of the equipment involved and the process.

The same general pattern is followed in bringing information to the reader on dielectric heating. A general chapter discusses the theory of dielectric heating and gives a comparison with induction heating. The chapter on energy sources for dielectric heating describes the equipment and some design considerations without going into the mathematics involved. A discussion of the electrodes, accessory equipment, and the various applications follows.

In this book the author has compiled data on the various uses of equipment of both types. He has tried to foresee many of the possible applications involving this equipment and has also pointed out some of the shortcomings. These factors alone make this book a valuable reference for anyone contemplating use of induction or dielectric heating.

ALSO AVAILABLE

STRESS CONCENTRATION DESIGN FACTORS, by R. E. Peterson; John Wiley & Sons; 150 pages; $8.50. A working tool for designers, this book is concerned with the improvement of design calculations that will result in better-balanced plans and ultimately reduce operating failure. Amplifying his graphic presentation with succinct explanatory notes, the author covers definition and design relations, grooves and notches, shoulder fillets, holes in plates or shafts, and miscellaneous design elements.

The author is manager of the Mechanics Department Research Laboratories, Westinghouse Electric Corporation. He has achieved a nation-wide reputation as an outstanding diagnostician of mechanical breakage.

consulting engineer

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